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SIDUS SIDARUM[1]

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In 1962 Lloyd H. Shinners launched the journal *Sida: Contributions to Botany* as a private venture. His choice of a name for the journal (using the name of the well-known and large malvaceous genus *Sida* L.) was commented upon by Mahler (1973) in the issue of the journal devoted to Shinners' memory. I find it curious, however, that in 12 years of publication of *Sida*, the genus of the same name has been mentioned in its pages only incidentally on two or three occasions. I think it appropriate that studies of the genus *Sida* should appear in the journal *Sida*. Few genera have that option (see Appendix). I offer the present notes as a beginning.

NOTE 1. TYPIFICATION OF SIDA SECTION MALACROIDEAE G. DON

This taxon, a natural group within *Sida*, was recently revised by Clement (1957), who followed Schumann (1891) in characterizing it. Clement correctly noted the priority of Don's epithet (*Malacroideae*) over that of Schumann (*Pseudomalachra*) even though Schumann's name had been used almost exclusively before Clement's study. However, Clement erred in indicating *S. ciliaris* L. to be the type species of the section, since Don did not include this species in his section. A lectotype should therefore be chosen from among the three species included by Don: *S. fulva* St.-Hil., *S. anomala* St.-Hil., and *S. plumosa* Cav.

I therefore choose *S. anomala* St.-Hil., Fl. Bras. Mer. 1:177. 1827 to lectotypify *Sida* sect. *Malacroideae* G. Don, Gen. Hist. 1: 498. 1831.

NOTE 2. A NEW SPECIES OF SIDA SECT. MALACROIDEAE G. DON

SIDA **meridiana** Fryxell, sp. nov., sectionis Malacroidearum (Fig. 1). Caules plures, ramosi, procumbentes, pallidi, dense stellato-pubescentes, pilis exalbidis, 0.5-2.0 mm longis, demum glabrescentes. Folia late elliptica, foliis plus amplis 15-18 mm longis, 10-13 mm latis, basaliter truncata vel leniter cordata, ad apicem obtusa, marginibus in dimidiis proximalibus integris, in dimidiis distalibus foliorum bene evolutorum manifeste 10-20 dentatis; pubescentia foliorum dense stellata, exalbida, utrinque similiter praeter supra antrorsa, marginibus ciliatis, pilis usque ad 2 mm longis. Petioli 4-6 mm longi, manifeste hirsuti, pili saepe simplicibus. Stipulae 4-8 mm longae, manifeste ciliatae, spatulatae, laminis acutis 1-3(-4) mm latis, in stipibus infra angu-

[1] Under this title (meaning "a constellation of Sidas") I propose to publish occasional notes on the genus *Sida*.

UB HERBÁRIO UNIVERSIDADE DE BRASÍLIA
PLANTS OF THE PLANALTO DO BRASIL
Collected for The New York Botanical Garden by W. R. Anderson, P. A. Fryxell, S. R. Hill, R. Reis dos Santos, and R. Souza
Estado de Minas Gerais
William R. Anderson
April 1973
Field work supported in part by funds from the National Science Foundation and conducted with the collaboration of the Universidade de Brasília and the Instituto de Pesquisas e Experimentação Agrícola do Norte.
Determ.: P. Fryxell
1974

Fig. 1. Photograph of the holotype of *Sida meridiana* Fryxell.

statis vel (praesertim in inflorescentiis apicalis) anguste lineares, congestae, et usque ad 12 mm longae. Flores in inflorescentia pauciflora, pseudoinvolucellata et apicali congesti, pedicellis 2-3 mm longis. Calyces 5-6 mm longi, basaliter luteoli, ad medium divisi, 5 lobis acutis, intus et extus dense hirsutis. Petala alba basibus flavidis, ca. 1 cm longa, in marginibus minute ciliatis, ceterum glabris. Columna staminalis glabra, pallida, ca. 3 mm longa; filamenta pallida; antherae et pollen aureae. Styli 5-6, androecium excedentes, pallidi; stigmata capitata, pallida. Fructus oblati, per calyces inclusi; mericarpia ca. 6, ad apicem breviter birostrata, in dorso rugosa et glanduloso-puberula (saltem ubi immatura), in lateribus grosse reticulata.

TYPE: BRAZIL: Minas Gerais: Rio Pandeiros, ca. 52 km by road W of Januária near road to Serra das Araras; elev. 520 m; sandy beach. Decumbent from perennial base; flowers white, open in afternoon, base of petals and stamens yellow. 21 Apr 1973, *William R. Anderson* et al. *9271* (holotype, UB; isotypes, NY, pf,[2] and to be distributed from NY).

The new species was found growing sympatrically with *S. ciliaris* (*Anderson* et al. *9265*; NY, UB, pf,[2] and elsewhere). The two species were distinct not only in gross morphology but also in floral biology. Since the plants were immediately adjacent to our site of encampment, we could observe them closely over a period of time.

The flowers of *S. ciliaris*, yellow-orange, undergo anthesis near dawn and remain open through the morning but are withered by noon. Flowers of *S. meridiana*, on the other hand, remain in tight buds through the morning, open shortly after noon, and wither 2 or 3 hours later. Flowers of *S. meridiana* are white with a yellow center, the yellow being characteristic of the anthers and of the bases of the petals.

Although the two species are sympatric to the extent that individual plants of one species grow within a few feet of those of the other species, they are completely isolated temporally in their floral behavior. The choice of the specific epithet of the new species is in reference to this midday flowering pattern.

In *S. meridiana* the flower buds and the developing fruits are concealed among the congested leaves at the apices of the branches and are therefore inconspicuous; the spent corollas of late afternoon are equally inconspicuous. Thus, the plants appear, superficially, to be vegetative except during the few midday hours when the flowers are open. Perhaps because of this relatively cryptic reproductive pattern, this species has not previously been recognized.

Sida meridiana may be distinguished from the other species of section *Malacroideae* by its broader leaves; by its more numerous teeth in the margins of the leaves; by its tendency to have leafy stems rather than bare stems with leaves crowded apically; by its broader stipules; by its dense whitish stellate indumentum, especially on the stems where, in other species (e.g., *S. anomala*), the hairs are sometimes submalpighiaceous and on the

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[2] Personal herbarium of Paul A. Fryxell.

upper leaf surfaces where, in other species, the hairs are either sparse or absent; and by the distinctive flowering pattern described previously.

NOTE 3. SIDA COLLINA IN MEXICO

The species *S. collina* Schlecht. is common in Mexico. However, it has not been well understood because it has often been confused with the more widespread and better-known *S. rhombifolia* L. When it has been distinguished from the latter species, it has been treated under the name *S. corymbosa* R. E. Fries. *Sida collina* is closely allied to *S. woronowii* Ulbr. but is distinct enough in general aspect not to be confused with it.

Both *S. collina* and *S. costata* have previously been considered as doubtful or unidentified species (Standley, 1923; Kearney, 1954), but the opportunity to examine the Schlechtendal types cited below has enabled me to establish this synonymy. This note further provides the occasion to add observations that more clearly distinguish *S. collina* from *S. rhombifolia*. I am grateful to Dr. K. Werner for making the Schlechtendal specimens available for examination.

SIDA COLLINA Schlechtendal, Linnaea 11: 364. 1837. Type: MEXICO: [Veracruz:] prope Hacienda de la Laguna, Jul 1829, *Schiede s.n.* (holotype: HAL-36722!); idem loc., Sep 1829, *Schiede s.n.* (paratype: HAL-36721!).

Sida costata Schlechtendal, Linnaea 11: 365. 1837. Type: MEXICO: [Veracruz:] prope Hacienda de la Laguna, Jul 1829, *Schiede s.n.* (holotype: HAL-34056-1!; isotype: HAL-34056-2!).

Sida corymbosa R. E. Fries, Bull. Herb. Boiss., ser. 2, 7: 998. 1907. Type: MEXICO: [Veracruz:] region d'Orizaba, 17 Aug 1866, *Bourgeau 2863* (G, K).

The type of *S. costata* is a more densely pubescent specimen than is the type of *S. collina*, but they appear to differ in no other significant respect. This difference in pubescence was the principal distinction noted by Schlechtendal. The types of all three names are from Veracruz, but the species is also well known from western Mexico in the states of Jalisco, Nayarit, and Sinaloa.

Both *S. rhombifolia* and *S. collina* are variable species. Instead of describing the particulars of that variation or its range, I only note those characters that consistently differentiate the two species, especially since currently available keys (Standley, 1923; Kearney, 1954) distinguish them imperfectly.

Pubescence. The herbage of *S. collina* is more or less pubescent with stellate hairs 0.5-1.0 mm long, although the hairs on the upper (adaxial) leaf surface are commonly simple and antrorsely oriented. By contrast, the herbage of *S. rhombifolia* is minutely puberulent with stellate hairs no more than 0.1 mm long. The nature of the indumentum in the latter species is such that the leaves are generally discolorous.

Stipules. The stipules of *S. collina* are considerably more prominent (7-12 mm long, 0.6-1.0 mm wide, often 3-nerved, ciliate) than are those of *S. rhom-*

bifolia (4-6 mm long, 0.2-0.5 mm wide, 1-nerved, puberulent). This prominence is especially noticeable if one compares a pair of stipules with the flower borne in the same axil. In *S. collina* the stipules usually exceed the peduncle and often are subequal to the calyx; in *S. rhombifolia* the stipules are only a fraction of the length of the peduncle.

Leaf form. The leaves of *S. collina* tend to be narrower, more nearly lanceolate-elliptic, and more sharply serrate than those of *S. rhombifolia,* which by contrast tend to be broader, more nearly rhomboid, and less prominently serrate.

Inflorescences. Although individual flowers are solitary in the axils in both species, they tend to form crowded, apical, corymbiform inflorescences in *S. collina,* whereas in *S. rhombifolia* the flowers generally are widely scattered and not crowded into apical aggregations. This difference is accentuated by a difference in peduncle length. The peduncles of *S. collina* are only rarely 1 cm long; they are more commonly subsessile. In *S. rhombifolia,* on the other hand, the peduncles are commonly 1-3 cm long and are sometimes subequal to the subtending leaf.

Flowers. In flowering specimens I have examined, the flowers of *S. collina* consistently have a large purple spot with radiating purple veins at the base of each petal. Flowers of *S. rhombifolia* lack basal petal spots. Flowers of *S. collina* are generally larger (calyx length: 8-10 mm) than those of *S. rhombifolia* (calyx length: 5-7 mm).

Carpel number. The number of mericarps per fruit or the number of styles and stigmas per flower is 7-9 in *S. collina,* 10-14 in *S. rhombifolia.* Schlechtendal's description "carpidiis 5" for *S. collina* is not supported by examination of type material.

REFERENCES

CLEMENT, I. D. 1957. Studies in *Sida* (Malvaceae). Contr. Gray Herb. 180: 1-91. (Sect. *Malacroideae,* 16-30)

KEARNEY, T. H. 1954. A tentative key to the North American species of *Sida* L. Leafl. W. Bot. 7: 138-150.

MAHLER, W. F. 1973. By any other name. *Sida* 5: 180-181.

SCHUMANN, C. 1891. Malvaceae I. Pages 253-456 *in* C. F. P. Martius, Fl. Bras. 12(3). (*Sida* sect. *Pseudomalachra,* 280-287)

STANDLEY, P. C. 1923. *Sida* Pages 761-767 *in* Trees and Shrubs of Mexico. Contr. U.S. Natl. Herb. 23.

APPENDIX

An unimportant digression on the titles of botanical journals

Many botanical journals have one-word titles that are coincident with the name of a genus. A quick tabulation provides me with a list of 81 such names, listed below. About one-third of these journals are no longer published, and it is difficult to be certain why most of these journals were named as they were.

However, in 57, marked below with an asterisk, the name of the journal was chosen presumably to honor a noted botanist, and the same name was

incidentally and independently chosen for a genus as another honor for the same botanist. Thus, the identity of the names of these journals and of the genera is only coincidental.

Ten, marked with a dagger, are specialty journals, mostly for horticultural enthusiasts. The titles of these are simply descriptive of the contents of the publication.

The titles of three journals, marked with a double dagger, are only accidentally identical to the names of genera. Three more, marked with a question mark, have names whose probable origins I am unable to judge.

Only the 10 journal names marked with a section mark (§) were chosen to commemorate genera. Three of these, *Betula, Erythea,* and *Nemophila,* are no longer published. The remaining names are *Araucaria, Castanea, Ceiba, Kalmia* (?), *Rhodora, Sarracenia* (?), *and Sida.* The brevity of this list is the basis for my statement (in the introduction to "Sidus Sidarum") that few genera can be written about in journals named in their honor.

Adansonia*
Addisonia*
Allionia*
Araucaria§
Arnoldia
Baileya*
Bartonia*
Bauhinia*
Belmontia?
Betula§
Billotia*
Blumea*
Blyttia*
Boissiera*
Bonplandia*
Borbasia*
Bragantia*
Brebissonia*
Brittonia*
Cactus†
Caldasia*
Candollea*
Castanea§
Cavanillesia*
Ceiba§
Cinchona†
Citrus†
Claytonia*
Dahlia†
Darwiniana*
Delphinium†
Delpinoa*
Dodonaea*
Drudea*
Dusenia*
Erythea§
Friesia*
Gladiolus†
Gorteria*
Grevillea*
Hedwigia*
Herbertia*
Iris†
Irmischia*
Kalmia* or §
Kudoa?
Lens‡
Lindenia*
Linnaea*
Lloydia*
Molina*
Malpighia*
Muhlenbergia*
Mutisia*
Nemophila§
Notarisia*
Orchis†
Persoonia*
Pittonia*
Preslia*
Regelia*
Reinwardtia*
Rhododendron†
Rhodora§
Rodriguezia*
Sargentia*
Sarracenia* or §
Sellowia*
Sida§
Sieboldia*
Sylvia‡
Teysmannia*
Torreya*
Urania‡
Vellozia*
Viola?
Vitis†
Watsonia*
Webbia*
Willdenowia*
Wrightia*

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* Name commemorates a botanist.
† Name describes content of a specialty (often horticultural) journal.
‡ Name accidentally coincides with a generic name.
? Name is of uncertain origin.
§ Name commemorates a plant genus.

NOTES PRELIMINARY TO AN ACCOUNT OF CASSIA IN THE CHIHUAHUAN DESERT

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ABSTRACT. Descriptive and interpretive taxonomy of CASSIA (Leguminosae: Caesalpinioideae) of the Chihuahuan Desert, involving 6 nomenclatural transfers: CASSIA sect. **Earleocassia** (Britt.), C. sect. EARLEOCASSIA ser. **Tharpia** (Britt. & Rose), C. CROTALARIOIDES Kunth var. **vogeliana** (Schlechtd.), C. **pilosior** (Macbr.), C. WISLIZENI Gray var. **villosa** (Britt.) and var. **painteri** (Britt.); 5 new taxa: C. DEMISSA Rose var. **radicans** (Coahuila), C. **mensicola** (Coahuila to Hidalgo), C. DURANGENSIS Rose var. **iselyi** (s. Tex. to San Luis Potosi), C. **ripleyana** (trans-Pecos Texas to n. Zacatecas), C. **monozyx** (Coahuila); and 1 new epithet: C. **parralensis** (= *Chamaecrista goldmanii* Britt. & Rose).

In the course of revising *Cassia* for the *Chihuahuan Desert Flora* in preparation, we have encountred several undescribed taxa and the need for a few nomenclatural changes. These are presented in the framework of Bentham's classification of the genus (1871).

I. Sect. EARLEOCASSIA (Britt.) Irwin & Barneby

CASSIA subgen. SENNA sect. **Earleocassia** (Britton) Irwin & Barneby, stat. nov. *Earleocassia* Britton in N. Amer. Fl. 24 (4): 247. 1930, pro gen.— Generitypus: *E. roemerana* (Scheele) Britt. = *Cassia roemerana* Scheele.

Cassia subgen. *Senna* sect. *Chamaefistula* ser. *Brachycarpae* Bentham in Trans. Linn. Soc. (London) 27: 529. 1871. — Sp. lectotypica: *C. roemerana* Scheele. — Non *Cassia* sect. *Chamaesenna* ser. *Brachycarpae* Bentham, op. cit. 552.

A well defined group of xerophytic cassias native to the Mexican Plateau, the Sonoran and Chihuahuan deserts, floristically related arid grasslands of southwestern United States, and tropical desert enclaves in south-central Mexico. The centers of diversification and abundance coincide within the Chihuahuan Desert, where 12 of the 18 described species are native and 5 endemic. The Brazilian *C. nana* Benth., still indifferently known, is provisionally excluded.

Characters common to all (or almost all) members of the section are: roots black in age; herbaceous stems dying back yearly usually to the ground; flaccid attenuate stipules; a complex vesture composed of short hairs, minute yellowish clavate ones, and stiffer longer setae; fusiform, often stipitate interfoliolar glands; a turbinate hypanthium heavily glandular about the torus; subequal obtuse sepals; petals expanded for 1 day, then wilting, fading

whitish when dried but coarsely arborescent-veined; and a pod, usually more or less turgid and internally septate, dehiscent downward along both sutures, the tips of the valves diverging to passively release the pear- or paddle-shaped seeds. Bentham considered his ser. *Brachycarpae*, of which he knew (disregarding *C. nana* and the probably also extraneous *C. mexicana* Jacq.) seven members, to form a transition between sect. *Chamaesenna* ser. *Corymbosae* and sect. *Oncolobium*, being close to the last in form, but not dehiscence, of the pod; different from both in the homomorphic sepals and from *Oncolobium* more decisively by want of the basal petiolar gland and lack of malodorous oils. The syndrome of characters listed, combined with a natural collective range of dispersal, characterizes a closely coherent and obviously natural group of species entitled to sectional rank within subgen. *Senna*. The chromosome number n = 14 (in tetraploid *C. crotalarioides* Kunth, n = 28) determined for 8 members of the section (Irwin & Turner 1960, p. 315) is the base number of subgen. *Senna*. In view of the fact that Bentham employed the epithet *Brachycarpae* for series in two different subgenera of *Cassia*, it seems preferable to take up at sectional level *Earleocassia*, proposed as a genus for an almost exactly conterminous group.

The monotypic genus *Tharpia* Britt. & Rose, consisting of the peculiar little subacaulescent *C. pumilio* Gray included in ser. *Brachycarpae* by Bentham, was said to differ from related segregates of *Cassia*, in particular from *Earleocassia*, in the want of a petiolar gland combined with subglobose, indehiscent pod. In reality, a petiolar gland, sometimes small and concealed between the narrow wings of the leafstalk, is consistently present, and the pod, now known to vary from subglobose to oblong, is tardily dehiscent downward from the tip, just as in other *Earleocassias*. The flowers and seeds of *C. pumilio* are essentially identical with those of *Earleocassia*, and in *C. ripleyana*, described below, we now have a species almost as dwarf, resembling *C. pumilio* in the scapiform, one-flowered peduncles and small turgid pod. Characters that remain peculiar to *C. pumilio* in context of its relatives are the tuberously thickened roots, the firm texture of the stipules and foliage, the thickened margins of the leaflets, and in particular the modification of the leaflets from asymmetrically oblong or obovate, cordate at base on the proximal side, to subsymmetrically linear-lanceolate, at base cuneate on both sides. We evaluate *Tharpia* as a monotypic series of sect. *Earleocassia*:

CASSIA subgen. SENNA sect. EARLEOCASSIA ser. **Tharpia** (Britton & Rose) Irwin & Barneby, stat. nov. *Tharpia* Britton & Rose in N. Amer. Fl. 23 (4): 246. 1930. — Sp. unica: *C. pumilio* Gray.

CASSIA CROTALARIOIDES Kunth var. **vogeliana** (Schlechtd.) Irwin & Barneby, stat. nov. *C. vogeliana* Schlechtd. in Linnaea 12: 342. 1838. *Earleocassia vogeliana* (Schlechtd.) Britt. ex Rose in N. Amer. Fl. 23 (4): 248. 1930.

Bentham (1871, p. 530) maintained *C. vogeliana* as akin to *C. crotalarioides* but different in the long spreading pubescence of stems and leafstalks combined with supposedly larger flowers. Britton & Rose (1 c.) relied for differential characters solely on vesture, and this indeed seems to be the only substantial difference. The collective range of the two entities encircles the southern margins of the Mexican Plateau from central Durango to Aguas Calientes and Guanajuato, thence east to Hidalgo, thence north along Sierra Madre Oriental to central Nuevo León. Along the segment of this great arc between Durango and Hidalgo the stem-pubescence is appressed or subappressed and composed of hairs mostly less than 1 mm long. From Hidalgo northward it becomes pilose and in extreme form shaggy-pilose with fine lustrous setae up to 3 mm long. Both types of vesture occur in Hidalgo (whence the type of *C. vogeliana*), and plants with occasional long spreading hairs scattered among the appressed ones form passage between the two.

CASSIA DEMISSA Rose var. **radicans** Irwin & Barneby, var. nov., a var. *demissa* caudice diffuse ramoso hinc inde radicanti, caulibus annotinis elatioribus (1-3.5 nec 0.8 usque dm longis), cauliumque pube hirsutula recedens. — MEXICO. Coahuila: s.-w. end of Sa. de la Fragua, 1-2 km n. of Puerto Colorado, 2. IX. 1941 (fl, fr), *I. M. Johnston 8774*.—Holotypus, TEX.

Hillsides and canyons, in izotal and chaparral, upward into the pinyon woodland, 1400-2100 m, strongly calciphile, scattered in the mts. of centr. and s. Coahuila from Sa. de la Madera s. through Sas. de Fragua and de Organos to Sa. de Parras and mts. s.-e. of Saltillo; apparently disjunct in extreme s.-w. Tamps.

Material seen: Coahuila: Sa. de Madera, *I. M. Johnston 9082* (TEX); ibid., Cañón de la Hacienda, *Hendrickson 11874, 13567* (TEX). Sa. de Organos, 62 air miles w.-s.-w. of Cuatro Ciénegas, *Henrickson 12156* (TEX). s. of Parras, *Stanford & al. 229* (NY); S. S. José del Refugio, *Chiang & al. 8267B* (NY); Saltillo, *Gregg 244* (NY); 17 mi. s.-e. of Saltillo, *Bierner & Turner 86* (NY, TEX).

Britton & Rose (1930, p. 284) knew *C. demissa* only from the plants collected by Pringle in 1889 near (probably east of) Carneros Pass in extreme southern Coahuila. Precisely comparable material has been encountered since then only within a narrow circumference of the type station: once close by at Fraile (*Stanford & al. 253*); once in adjoining Zacatecas (*Chiang & al. 7938*); and once in the Sierra Madre Oriental near Pablillo (*M. Taylor 153*). Northward in Coahuila, from a line connecting Sierra de Parras and Saltillo by way of General Cepeda northward to Sierras de Madera and La Fragua, the species is represented by the coarser, taller form described as var. *radicans*, different from var. *diffusa* in its openly branched, often adventitiously rooting caudex, hirsutulous pubescence of the stems, and usually ampler, always more coarsely pilose foliage. The oldest known collection of var. *radicans*,

Gregg 244 from near Saltillo in 1848/9, was mistakenly referred by Bentham (1871, p. 530) and by Britton (in hb.) to *C. vogeliana* Schlechtd., a species similar in gross aspect but with 4-5, not 2 pairs of leaflets. One flowering specimen from the southwestern corner of Tamaulipas (*Stanford & al. 829*, NY) is provisionally referred to var. *radicans* but may yet prove to represent a distinct form. It resembles the Coahuilan plants in general habit, but is notable for some very long spiral hairs on the upper stems, suggesting the shaggy pilose vesture of the genuine *C. vogeliana*, vicariant southward in the Sierra Madre.

CASSIA **pilosior** (Macbride) Irwin & Barneby, stat. nov. *C. bauhinioides* var. *pilosior* Robinson ex Macbride in Cont. Gray Herb. n. ser. 59: 27. 1919. — "TEXAS: Bofecillos Mts., Sept. 1883, *Harvard*, no. 14. . . . MEXICO: *Torreón*, Coahuila, Oct. 13-20, 1898, *Palmer*, no. 455; 75 miles southwest of Parras, Coahuila, May, 1880, *Palmer*, no. 2132." Lectoholotypus (Isely, Leg. U.S. II. Subfam. Caesalpinioideae, ms.): *Havard 14*, GH.

Cassia durangensis sensu B. L. Turner, Leg. Tex. 74, map 35. 1959; sensu Correll & Johnston, Man. Vasc. Pl. Tex. 788. 1970.

Confusion of *C. pilosior* with genuine *C. durangensis* Rose started with Britton's account of *Earleocassia* (Britt. & Rose, 1930, p. 248) and has been perpetuated in the Texan literature. The two species are certainly close allies, but upon examination of material taken throughout their ranges are found to be differentiated by the following syndrome of characters:

a. Weak spiral hairs up to 2-4 mm present on upper stem and leafstalks; sepals marcescent about the forming pod; style filiform, 2.5-3.2 mm long, 0.2-0.25 mm diam; fl. small, the petals 8.5-10 mm; ripe pod strongly compressed, the septa between seeds very narrow (to 0.3 mm wide); seeds smooth; trans-Pecos Texas to n.-e. Durango and s. Coahuila. . . . . *C. pilosior*

a. Longer hairs mostly less than 2 mm, setiform (some long spiral ones in distantly allopatric var. *iselyi*); sepals promptly deciduous at anthesis; style 1-2 mm long, 0.3-0.4 mm diam; fl. variable in size, but where nearly allopatric with *C. pilosior* larger, the petals 10-13 mm; pod turgid, the septa broader; seeds strongly rugulose; bicentric in dispersal, var. *durangensis* local around margins of Mapimí depression in s.-e. Chihuahua and e. Durango, var. *iselyi* on the Gulf Coastal Plain in extreme s. Texas and Tamaulipas. . . . . *C. durangensis*

The known range of *C. pilosior* extends from the Rio Grande valley in Brewster and Presidio counties, Texas, south to the periphery of the Mapimí depression in southwestern Coahuila, eastern Chihuahua, and immediately adjoining Durango. In the lower Nazas valley southwest of Torreón *C. pilosior* and *C. durangensis* var. *durangensis* have been collected within a radius of a few kilometers of Cuencamé (*Irwin 1231, 1234*) but despite essential sympatry are there sharply marked.

CASSIA DURANGENSIS Rose var. **iselyi** Irwin & Barneby, var. nov., a var. *durangensi* vix nisi pedunculis pauci (1-3, nec 2-5)-floris necnon glandula petiolari sessili glaberrima (nec stipite villosulo elevata) recedens sed patria valde remota separanda. — MEXICO. Tamaulipas: San Fernando à Jimenez [Santander], X.1830 (fr) *J. L. Berlandier 840.* — Holotypus, NY; isotypus, K.

Mesquite thickets and along roadsides and canal banks of the Gulf Coastal Plain below 300 m, in sandy or sandy loam soils, lower Rio Grande valley in extreme s. Texas (Zapata, Starr, Hidalgo, Cameron cos), s. through Tamaulipas just into San Luis Potosí.

Representative: UNITED STATES. Texas, Zapata: Zapata, 14.XI.61 (fr), *Cabrera & Munoz 50* (TEX). Starr: road to McCook, 9.X.54 (fr), *Tharp & M. C. Johnston 541888* (TEX). Hidalgo: Lomita Alta, 18.VI.37 (fl), *C. E. R. Cameron 30* (TEX). Cameron: Olmito, 15.X.36 (fl), *R. Runyon 2992* (TEX). MEXICO. Tamaulipas: Río Purificación, 7 mi. n. of Padilla, *Hagee & Kerr 1059* (SMU); Río Blanco to Victoria, *Karwinski in 1842* (LE); Victoria, *Berlandier 2260* (K, NY). San Luis Potosí: Salto de Agua, mun. Cd. del Maíz, *Shott & Drewe 54* (SMU).

While one of the earliest collections (*Berlandier 2260*, NY) of var. *iselyi* was correctly referred by Britton (in hb.) to *C. durangensis*, modern collections, especially those from southern Texas, have passed, surprisingly, as *C. bauhinioides*, although fundamentally different in the broad leaflets, cylindric style, and straight pod. It differs, in fact, only very slightly from genuine *C. durangensis* of the Chihuahuan Desert in its glabrous sessile petiolar gland and usually 1-2, rarely 3-flowered peduncles. The dispersal of the two varieties is remarkable, var. *durangensis* being known from the upper forks of the Conchos and Nazas rivers in southeastern Chihuahua (n.-e. of Parral) and eastern Durango at elevations of some 1400-1570 m, whereas var. *iselyi* is confined to the Gulf Coastal Plain below 300m. A hispidulous ecotype of *C. bauhinioides*, distinguished by its very small, sometimes cleistogamous flowers and prevailing 1-flowered peduncles is the only *Earleocassia* known to enter the edge of the range of var. *iselyi*, reaching Starr and Zapata counties in the Rio Grande valley (*Runyon 1719, 2605*, TEX) and northern Nuevo León (*Ripley & Barneby 13252*, NY). This, however, with the narrow leaflets and dilated style of its species, is probably not truly sympatric with var. *iselyi*, occurring in Texas on gravelly hilltops and in adjacent Mexico on the calcareous first bench of Sierra Madre, apparently never straying out onto the sandy and loam soils of the Coastal Plain proper.

The variety is named for our friend Duane Isely, distinguished student of Leguminosae, who first recognized the distinct character of the taxon in relation to the polymorphic *C. bauhinioides*.

CASSIA **mensicola** Irwin & Barneby, sp. nov. inter *C. bauhinioidem* A. Gray et *C. roemeranam* Scheele quasi intermedia, illam habitu simulans sed floribus majusculis (petalis 11-18 nec 6-10 mm longis), stylo exacte cylin-

drico 0.2-0.3 mm tantum diam, necnon seminibus laevibus cito extricanda, ab hac, quoad florum magnitudinem stylique forma praesimili, imprimis statura minori (caulibus 0.5-2, rarius 2.5 dm usque, nec 2-7 dm longis) foliolis minoribus oblongo-ellipticis obtusis pro rata latioribus (2-3 nec 4-9-plo longioribus quam latis), patriaque procul aliena abstans. — MEXICO. San Luis Potosí: Charcas, VII-VIII. 1934 (fl, fr), *C. L. Lundell 5345*. — Holotypus, CAS; istotypus, LL, TEX.

Loosely cespitose perennial herbs, in habit resembling *C. bauhinioides*, the mostly simple, incurved-ascending stems 0.5-2 (2.5) dm, these and the leaf-stalks pilosulous with short subretrorse and minute yellow clavate hairs mixed with a few coarser ascending setae to 0.4-1 mm, the leaflets (dry) ashen beneath, golden-green above, pilosulous both sides, the axillary, few-flowered racemes short-exserted. Leaves (2-) 2.5-5 (-5.5) cm; stipules lance-caudate 4-8 mm; petioles 1-2.7 cm; intrafoliolar gland slenderly fusiform acute, including the often puberulent stipe 0.8-1.5 mm; leaflets 1 pair, narrowly oblong or oblong-elliptic obtuse, minutely mucronulate, (10-)12-37 X 3-11(-12) mm, mostly 2-3 times longer than wide; peduncles 2-4(-4.5) cm; racemes (1-)2 (-4)-flowered, the axis 0-11 (-15) mm; bracts 2.5-4.5 mm; pedicels 4-9 (-12) mm; sepals narrowly elliptic to elliptic-obovate obtuse, (5-) 5.5-8.5 (-9.5) X 2.2-3.6 mm; petals yellow drying whitish, broadly oblanceolate to obovate-cuneate, 11-16.5 (-18) X 6-11 (-12) mm, arborescently 3-veined from claw; androecium of *C. bauhinioides;* style slenderly cylindric 1.4-2.8 X 0.2-0.3 mm; ovary pilosulous; ovules 34-42. Pod linear-oblong, usually a trifle incurved, 2.3-3.5 X 0.35-0.55 cm, moderately turgid, the valves at once densely minutely puberulent and setose with ascending hairs to 0.9-1.2 mm, the cavity narrowly septate; seeds paddle-shaped, 2.2-2.5 mm, the testa bluntly folded and ridged but otherwise smooth or almost so, dark lustrous brown.

Gravelly clay flats and hillsides, in desert or desert grassland, sometimes on roadsides, mostly, perhaps exclusively calciphile, 900-2300 m, Meseta Central of n. Mexico from upper Moctezuma valley in n. Hidalgo (Ixmiquilpan) n. through San Luis Potosí and adjacent Zacatecas to s.-e. Coahuila.

Representative: COAHUILA: 15 km w. of Concepción del Oro, 19.VII.41 (fl), *Stanford, Wetherford & Northcraft 500* (NY); s. of Saltillo, 29.VII.29 (fl), *R. Runyon 1338* (NY, TEX). Zacatecas: w.-n.-w. of Tecolotes on road to Coapa, 17.VI.72 (fl), *Chiang, Wendt & Johnston 7895* (NY); e. of Troncoso 6.IV.70 (fl), *Mahler 5757* (SMU). SAN LUIS POTOSI: San Luis Potosí and vicinity, 2.IX.02 (fr), *Pringle 9728* (NY), in 1879, *Perry & Palmer 206* (NY), *Schaffner 624/831* (NY). HIDALGO: Ixmiquilpan, VII.05 (fl), *Rose Painter & Rose 8999* (NY, US), *Purpus 1370* (NY).

Five collections of *C. mensicola* known to Britton in 1930 were referred by him to *C. bauhinioides*, and modern ones have generally been so identified, following the key to *Earleocassia* in *North America Flora.* The two species, although widely separated geographically, are indeed similar in stature and foliage, but *C. mensicola* differs in the conspicuously larger flower, the syl-

indric style, and the smooth seeds. Its flower is essentially like that of the probably more closely related *C. roemerana,* but this differs in the greater stature (stems mostly 2.5-7, not 2-2.5 dm), in the longer, proportionately narrower and more acute leaflets (4.5-9.5 not 2-3 times longer than wide), which are in consequence of their length, at least in all upper leaves, more and not less than twice as long as their petiole. The range of *C. mensicola,* a very natural one extending over the southern part of the Chihuahuan Desert province southward from the Coahuila-Zacatecas boundary at approximately 25° N. into Hidalgo, is fully disjunct from that of *C. roemerana,* a species common over Edwards Plateau, trans-Pecos Texas, and desert segments of the Pecos and Rio Grande valleys in New Mexico, which extends south only feebly into Mexico, in Coahuila to near 28° and along the east piedmont of Sierra Madre Oriental to near 26° N. in Nuevo León.

CASSIA **ripleyana** Irwin & Barneby, sp. nov., inter affines sect. *Earleocassiae* foliolis 1-jugis signatas legumine breviusculo turgido inter semina late septato *C. bauhinioidem* A. Gray spectans, sed habitu pumilo caespitoso, pedunculis (plerisque 1-, paucis raris 2-floris) scapiformibus, styloque elongato filiformi apice haud dilatato, necnon seminibus laevissimis (nec rugulosis) recedens. MEXICO. Chihuahua: arid calcareous flats, ± 1400m, 18 km w. of Jiménez (27° 5' N, 105° 10' W), 2.X.1965 (fr), *H. D. Ripley & R. C. Barneby 13,904.*—Holotypus, NY.

Dwarf, laxly cespitose, subacaulescent perennial herbs from woody taproot and (when adult) a pluricipital caudex, pilosulous throughout with coarser, forwardly incurved-ascending hairs less than 1 mm and a few weak spreading filiform ones to ± 2-2.5 mm, the 1 pair of leaflets ashen beneath, greener above, silky-pilosulous both sides. Stipules erect, narrowly linear-caudate (4-) 6-10 mm, strongly 1-nerved, the filiform glabrescent tips often recurved. Leaves 1-5 cm; petiole stiff but subfiliform, 1-2.5 (-3.2) cm; intrafoliolar gland linear-claviform 0.7-2.4 mm; leaflets oblong- to obliquely obovate-elliptic, obtuse mucronulate or subapiculate, (6-) 8-20 X 3 -10 mm, at base broadly cordate on proximal and cuneate on distal side. Peduncles stiffly erect or in age declined, 2.5 cm, 1 (-2)-flowered; bracts triangular-subulate 1-1.5 mm; pedicels 5-8 mm; buds nodding, obtuse, pilosulous. Sepals 5.5-6.5 mm, the outer elliptic-oblanceolate, the inner obovate, all membranous-margined; petals yellow (whitish when dry) not widely expanding, all spatulate-oblanceolate, short-clawed, 8.5-9.5 X 5-6 mm, arborescently 3-veined from claw; androecium of *C. bauhinioides*; ovary densely pilose; style 3-3.5 X ± 0.3 mm, filiform-cylindric; ovules 18-28. Pod in outline oblong-oblanceolate, straight or slightly incurved, (13-) 15-24 X 5-8 mm, abruptly subulate-beaked, turgid, the ripe valves papery, brown, hispidulous with coarse, basally dilated ascending setae up to 0.7-1 mm, dehiscent downward through both sutures, the valves narrowly gaping to release the seeds. Seeds paddle-shaped, ± 2-3.5 mm, the testa olivaceous or pinkish-brown, smooth,

lustrous.—Fig. 1.

Gravelly hilltops and flats in arid grassland and Larrea desert, ± 1400-1660 m, local within the borders of the Chihuahuan Desert from trans-Pecos Texas (Glass Mts., Brewster Co.) to s.-e. Chihuahua near Bolsón de Mapimí (w. of Jiménez; Rancho La Gloria) and extreme n. Zacatecas (Cedros), not yet collected but to be expected in n. and w. Coahuila.

Material seen: UNITED STATES. Texas. Brewster: Glass Mts., 13.VII.40 (fl, fr), *Warnock W-44* (TEX); s. l., 9.X.36, *Tharp s. n.* (CAS, in part, mixed with *C. bauhinioides*). MEXICO. Chihuahua: Sa. del Diablo 14 km s.-e. of Rancho La Gloria, 29.VIII.72 (fr), *Chiang & al. 9000d* (TEX). Zacatecas: n. of Cedros, 22.IX.73 (fl, fr), *Reveal & Atwood 3357* (NY, US).

A neat little cassia related to *C. bauhinioides* but readily distinguished by the tufted habit, the wiry scapiform peduncles, and the lustrously smooth olivaceous to pinkish-brown seeds. The subacaulescent growth-form and relatively stiff stipules recall *C. pumilio* Gray, but the oblong-obovate, basally semicordate leaflets are entirely different.

Named in memory of Harry Dwight Dillon Ripley, 1908-1973, an avid collector and eclectic devotee of small and rare desert plants, who in the field noted of the type-collection: "near *C. bauhinioides*, but not the same."

II. Section CHAMAESENNA Bentham

The genus *Palmerocassia* Britt. (1930, p. 253), based on *Cassia wislizeni* A. Gray, consisted in the first instance of five species, endemic to desert regions of Mexico and immediately adjoining United States. They are twiggy, subspinescent, microphyllous shrubs and treelets with glandless leafstalks, large flowers, the androecium and tardily dehiscent, compressed pod of sect. *Chamaesenna* Benth., forming in Bentham's scheme of classification a xerophytic offshoot of the *Eglandulosae* series. An interesting feature of the group is the dimorphic foliage, an adaptation to desert climate achieved by many Leguminosae of different groups. The leaves of the current season are solitary, but subtend in their axil a compressed-conical bud which, lying dormant the first year, develops during the second into a brachyblast, taking the form of a fascicle of small leaves intermixed with setiform stipules.

Three of Britton's five *Palmerocassias* are almost or quite confined to the Chihuahuan Desert, but are so closely related that they may best be interpreted as geographic varieties of a widespread *C. wislizeni*; their differential characters appear in the key following. The perhaps also closely related *C. pringlei* Rose, differing in the often more flexuous branches and greatly elongated pod (18-29 not 8-16 cm long) represents this complex in the Balsas Depression and low valleys of Oaxaca; while *C. unijuga* Rose, locally endemic in southern Puebla, is well marked by the combination of villous pubescence and unijugate leaflets with revolute margins. A parallel reduction of the leaflets to one pair has occurred also in the Chihuahua Desert, described below as *C. monozyx*. The members of the group occurring in our range are

Fig. 1. *Cassia ripleyana* Irwin & Barneby. Habit X1; sepals + petal (ventral view) X2; ovary and seed X5.

separable as follows (Fig. 2):

1. Leaflets 2-6 pairs (*C. wislizeni*, sens. lat.)
   2. Pubescence of young branchlets, leafstalks, and (if present) of leaflets appressed or forwardly subappressed.
      3. Stipules of primary leaves persistent; leaflets of primary leaves mostly 3 pairs, the largest 3-10 mm long, on lower (or both) faces coarsely penninerved; s.-e. Chihuahua (Sas. del Diablo, Hechiceros, Encinillas) and Chihuahua Desert n. from middle Conchos valley to Rio Grande valley in trans-Pecos Texas (Hudspeth, Jeff Davis, Presidio cos), the adjoining s. corners of New Mexico and Arizona, and thence w. to the Magdalena valley in n. Sonora. . . 1a. *C. wislizeni* var *wislizeni*
      3. Stipules of primary leaves caducous; leaflets of primary leaves 3-5 (-6) pairs, the larger ones 5-15 mm long, the venation of the lower face not or scarcely elevated, commonly immersed; Chihuahua Desert, s. and s.-e. from n.-w. Zacatecas and extreme s. Coahuila to n. Querétaro, e. feebly into s. Nuevo León and extreme s.-w. Tamaulipas. . . . . 1c. *C. wislizeni* var. *painteri*
   2. Pubescence of young branchlets, leafstalks, and leaflets spreading, villosulous; leaflets in number, size, and venation as in var. *wislizeni*; local around edge of Mapimí Depression in extreme s.-w. Coahuila and adjacent Durango. . . . . 1b. *C. wislizeni* var. *villosa*
1. Leaflets 1 pair; w.-centr. and s.-centr. Coahuila. . . . 2. *C. monozyx*

CASSIA WISLIZENI A. Gray var. **villosa** (Britton) Irwin & Barneby, stat nov. *Palmerocassia villosa* Britton in N. Amer. Fl. 23 (4): 254. 1930.

CASSIA WISLIZENI A. Gray var. **painteri** (Britton) Irwin & Barneby, stat. nov. *Palmerocassia painteri* Britton in N. Amer. Fl. 23 (4):254. 1930.

CASSIA **monozyx** Irwin & Barneby, sp. nov., *C. wislizeni* Gray arcte affinis imprimis foliolis 1 (nec 2-3)-jugis primo intuitu absimilis, a *C. unijuga* Rose pube sparsa appressissima vel subnulla (nec copiosa molli patula) patriaque aliena distat.—MEXICO. Coahuila: limestone ridge, 1800 m, Valle Seco in Sierra da la Paila, mun. General Cepeda, 7.VI.1944, *G. Hinton 16565*.—Holotypus, NY.

Erect, stiffly branched, subspinescent shrubs to 1 m, the old trunks fuscous glabrous, the young branchlets strigulose with appressed hairs to 0.25 mm, early glabrate, the foliage glabrous or the leaflets thinly strigulose dorsally. Leaves solitary only on young branchlets, mostly fasciculate from knotty brachyblasts, 5-15 mm; stipules setiform, 1-4 mm, persistent; petiole (1-) 1.5-5 mm; leaflets 1 pair obovate or cuneate-obovate, 3-9 (10) mm, at apex commonly apiculate, rarely retuse and mucronulate, the blades stiffly chartaceous, yellow-green or glaucescent, the midrib and 3-5 (-6) pairs of secondary veins prominulous both faces. Racemes loosely 1-4-flowered, axillary to reduced upper leaves, forming a small panicle, the axis often shorter

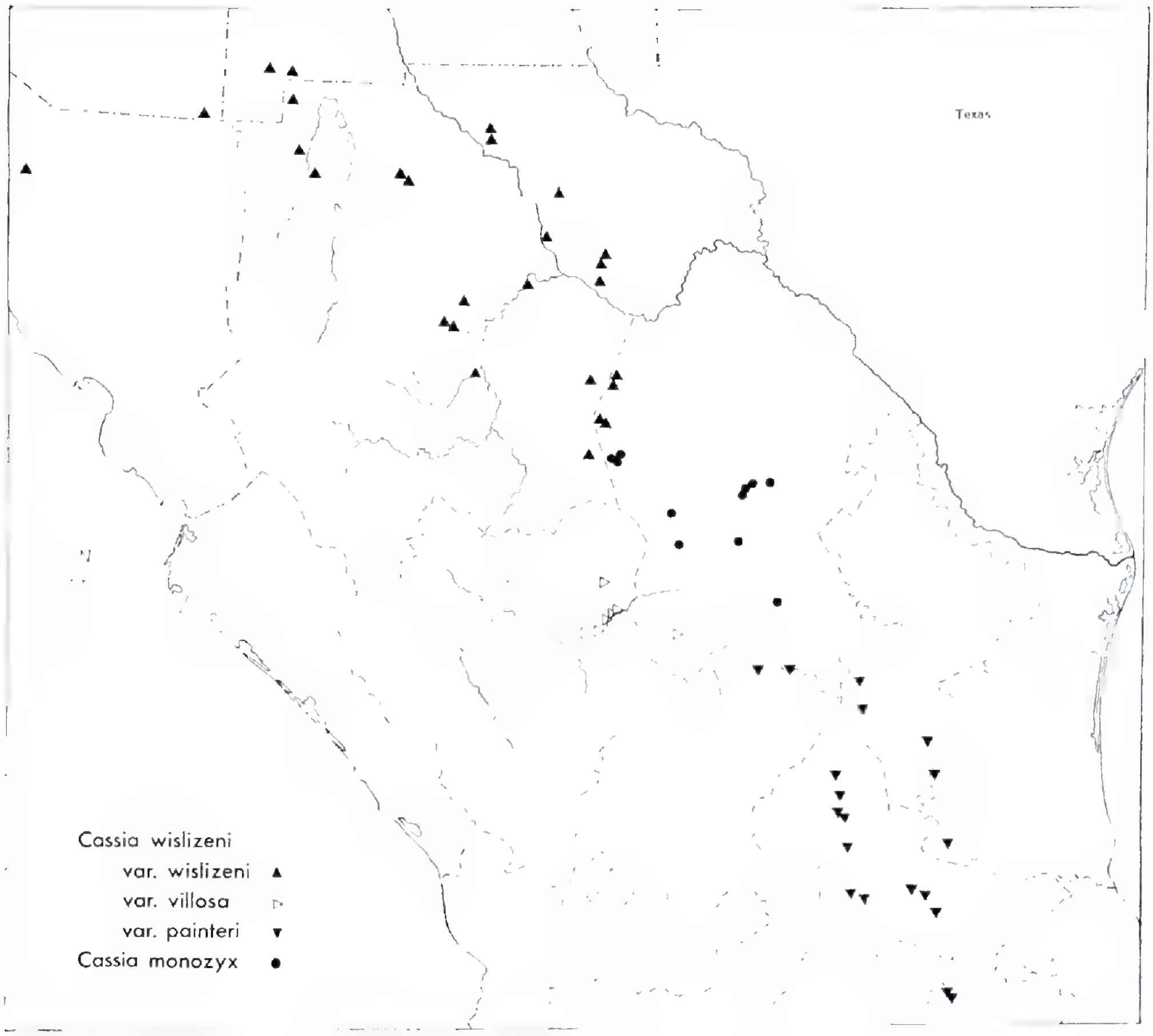

Fig. 2. Distribution of *Cassia monozyx* and the varieties of *Cassia wislizeni*.

than the flexuous pedicels; buds globose, except for the minutely ciliolate sepals glabrous; sepals oblong-elliptic to suborbicular obtuse, 4.5-7 mm, petaloid-margined; petals yellow, the largest ± 18-20 mm; ovary glabrous; ovules ± 10-15; pod linear, 6-10 X 0.65-0.8 cm, contracted at base into a short stipe, the purplish-nigrescent lustrous valves expressed over the rhombic-compressed, dull brown seeds.

Gravelly clay slopes of bajadas and canyons at and near base of calcareous mountains, 750-1500 m, w.-centr. to s.-centr. Coahuila (Sa. Mojada e. to Sa. de la Madera, s. to Sa. de la Paila).

Material seen: COAHUILA. Sa. Planchada n. of Esmeralda, 16.VIII.40 (1vs), *Johnston & Muller 343 (TEX)*. Sa. Mojada s. of Esmeralda, 1.IX.72 (fl, fr), *Chiang & al. 9066* (NY). Cañón de Calabazas in Sa. Mojada, 6.v.73 (fl), *M. C. Johnston & al. 10883* (NY). Sa. de la Madera 8 km w. of Cuatro Ciénegas, 5.VIII.73 (fl), *M. C. Johnston 12084F* (NY). 13 km s.-w. of Cuatro Ciénegas, 11. VI. 72 (fl), *Chiang & al. 7633* (NY). Cuatro Ciénegas, 23.VIII.39 (fl), *E. M. Marsh 2060* (TEX). 7 mi. w. of Sacramento on road from Mon-

clova to Cuatro Ciénegas, 12.VI.55 (fl), *M. C. Johnston 2584A* (TEX). Sa. de Organos 62 km w.-s.w. of Cuatro Ciénegas, 8.VIII.73 (fl, fr), *Hendrickson 12170b* (TEX). n.-w. of Las Delicias, 29.VIII.71 (fl), *Henrickson 6098b* (TEX). Sa. de los Alamitos 11 mi. n. of Australia, 13.VI.72 (fl, fr), *Chiang & al. 7723* (TEX).

Closely akin to *C. wislizeni* Gray and *C. unijuga* Rose, in habit and details of flower and fruit resembling both, but different from the first in the constantly bifoliolate leaves, those of the primary branchlets and secondary short-shoots being essentially alike, and from the latter in the sparse appressed, not copious and villous pubescence of the young stems and foliage, and in the smaller, firmer, more veiny, non-revolute leaflets. The two bifoliolate species, *C. unijuga* and *C. monozyx*, are widely separated geographically, the former being endemic to the Tehuacán Desert in Puebla, the latter to a small segment of the Chihuahuan Desert in Coahuila, distant 900 km apart. The accompanying map shows the vicariant dispersal of *C. monozyx* and *C. wislizeni* with its varieties which together form a replacement series occupying virtually the whole floor of the Chihuahuan Desert.

III. Sectio CHAMAECRISTA Bentham emend. Irwin

CASSIA **parralensis** Irwin & Barneby, nom. nov. *Chamaecrista goldmanii* Britton & Rose in N. Amer. Fl. 23 (5): 285. 1930. Non *Cassia goldmanii* Rose (1906).

REFERENCES

BENTHAM, G. 1871. Revision of the genus *Cassia*. In Trans. Linn. Soc. (London) 27: 503-591, t. 60-63.

IRWIN, H. S. & B. L. TURNER. 1960. Chromosomal relationships and taxonomic considerations in the genus *Cassia*. In Am. J. Bot. 47 (4): 309-318.

AN SEM STUDY OF LEAF SURFACE PUBESCENCE IN THE SOUTHEASTERN TAXA OF PERSEA[1]

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Scanning electron microscope (SEM) studies of anatomical and morphological structures are rapidly appearing in the systematic literature. Although most of these studies have dealt with spore or pollen grain architecture, Faust and Jones (1973), in *Vernonia,* and Mulligan (1971), in *Draba,* recently used the SEM for systematic purposes in examining leaf trichomes. For the most part, however, SEM studies of anatomical structures associated with leaf surfaces, i.e., distribution and morphology of hairs, glands, stomata, etc., have been generally ignored by systematists.

SEM studies of leaf pubescence were included as part of a biosystematic study of the genus *Persea* (Lauraceae) in the southeastern United States (Wofford, 1973). On the basis of these and other data, *P. palustris* (Raf.) Sarg., *P. humilis* Nash, and *P. borbonia* (L.) Spreng, are recognized as distinct species and *P. littoralis* Small is considered to be nothing more than a coastal dune ecotype of *P. borbonia.* According to Small (1903), the leaf blades of *P. borbonia* are "finely reticulated beneath and mainly over thrice as long as wide" while the leaf blades of *P. littoralis* are "not reticulated and mainly about twice as long as wide." These differences, however, are inconsistent and clearly represent morphological adaptations to the environmental conditions operative on coastal dunes.

METHODS

Lower leaf surfaces (ca. 5 mm^2) were mounted with plastic cement to standard ¾ inch aluminum studs. The mounted specimens were coated with vaporized carbon and gold *in vacuo* using a Denton vacuum coater equipped with a random rotating head. The specimens were viewed on an AMR model 900 Scanning Electron Microscope provided by the Department of Chemical and Metallurgical Engineering, The University of Tennessee, Knoxville.

DISCUSSION

The relatively small, unicellular, cupreous, filiform leaf trichomes in the southeastern taxa of *Persea,* provide the most reliable set of characters for readily distinguishing species. Several characters elucidated using the SEM,

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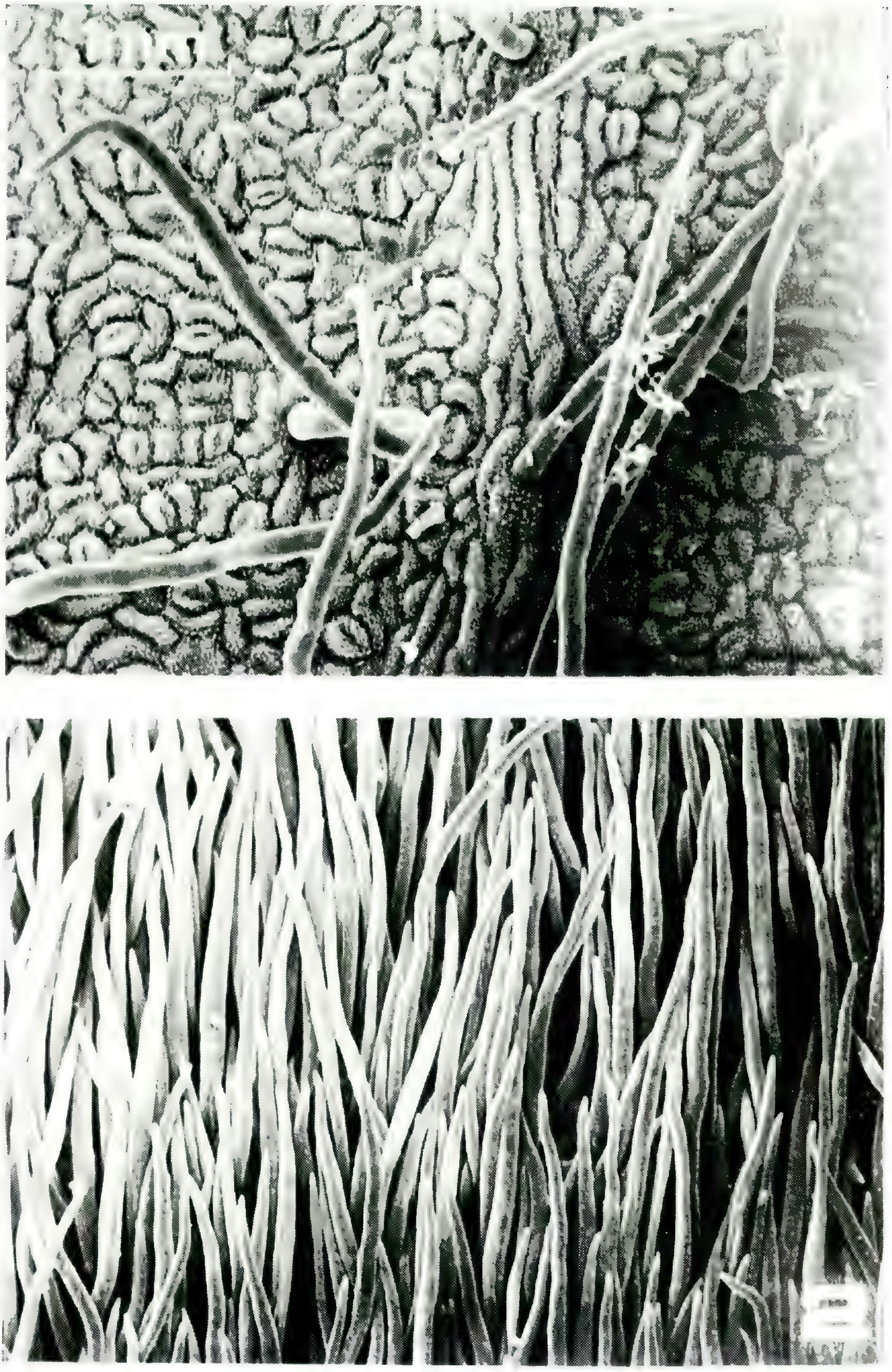
[1] Contributions from the Botanical Laboratory, University of Tennessee, Series Number 449.

SIDA 6(1): 19—23. 1975.



e.g., trichome length and density, are not adequately resolved with the dissecting microscope.

Persea palustris (Fig. 1), the most widespread and commonly encountered species, occurs throughout the Coastal Plain from eastern Virginia south to Florida and west to eastern Texas. This species possesses lanate trichomes that easily separate it from the sericeous type of *P. humilis* (Fig. 2) and the strigose type of *P. borbonia* (Fig. 3). The trichomes of *P. palustris* are moderately distributed over the lower leaf surface.

Persea humilis (Fig. 2), a central Florida endemic, is restricted to the evergreen oak-sand pine-scrub community. The moderately falcate, sericeous hairs of this species resemble those of *P. borbonia* (Fig. 3) with the exceptions of being denser and much longer. Also, the trichomes of *P. humilis* are about half as long as those of *P. palustris*. The shiny, cupreous trichomes of this species provide a reliable field character and make the common name "silk bay" an understandable one. As Nash (1895) stated, "*Persea humilis*, a most beautiful little shrub, makes itself very conspicuous by its bright brown silky pubescence, which is noticeable a long way off."

Persea borbonia (Fig. 3) has a distribution similar to that of *P. palustris* except that it is absent from Virginia and is restricted primarily to the outer Coastal Plain. The strigose hairs of this species, as previously stated, resemble those of *P. humilis* but are shorter and much less dense.

Persea littoralis, sensu Small (Fig. 4), now considered only a sand dune variant of *P. borbonia*, was found to show no differences in pubescence type, length, and density from that of *P. borbonia*.

In a statistical analysis of trichome length, using the Duncan's Multiple Range Test, Wofford (1973) found significant differences among all three species but no differences between *P. borbonia* and its sand dune ecotype (*P. littoralis*). Mean values (mm.) for each taxon are: *P. littoralis*, 0.14; *P. borbonia*, 0.16; *P. humilis*, 0.26; and *P. palustris*, 0.58. Intraspecific variations in trichome density were observed but are considered to be a function of age rather than being genetically based.

The pubescence type of *P. palustris* is quite distinct from that of the other taxa examined in being much longer and held in an upright position. The hairs of *P. borbonia* (including *P. littoralis*) and *P. humilis* are similar in type but are denser and much longer in *P. humilis*. It is not the intent of this paper to suggest one-character taxonomy but rather to point to the taxonomic and systematic potential of SEM leaf surface studies since the specimen can be more critically examined and the SEM micrographs are far superior to other methods of illustration.

Fig. 1-2. Scanning electron micrographs of *Persea* pubescence. Fig. 1, *P. palustris*. Fig. 2, *P. humilis*.

3

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REFERENCES

FAUST, W. Z. and S. B. JONES, JR. 1973. The systematic value of trichome complements in a North American group of *Vernonia* (Compositae). Rhodora 75: 517-528.

MULLIGAN, G. A. 1971. Cytotaxonomic studies of the closely allied *Draba cana, D. cinera* and *D. groenlandica* in Canada and Alaska. Canad. J. Bot. 49: 89-93.

NASH, G. V. 1895. Notes on some Florida plants. Bull. Torrey Bot. Club 22: 141-161.

SMALL, J. K. 1903. Flora of the southeastern United States. Published by the author, New York. 1370 p.

WOFFORD, B. E. 1973. A biosystematic study of the genus *Persea* (Lauraceae) in the southeastern United States. Doctoral Dissertation, University of Tennessee, Knoxville.

Fig. 3-4. Scanning electron micrographs of *Persea* pubescence. Fig. 3, *P. borbonia*. Fig. 4, *P. littoralis, sensu* Small.

A BIBLIOGRAPHY OF MANUALS AND CHECKLISTS OF AQUATIC VASCULAR PLANTS FOR REGIONS AND STATES IN THE CONTERMINOUS UNITED STATES[1]

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In the conterminous United States considerable interest has been shown in the identification and cataloguing of aquatic vascular plants, especially since 1940. This interest has undoubtedly been fostered because of the development of various areas of the aquatic sciences, such as aquatic botany, wildlife and fisheries management, wildlife conservation, and environmental protection agencies. The need for basic information on identification manuals and checklists of aquatic vascular plants for all areas of the United States has therefore become increasingly more frequent.

This paper provides a ready reference list of all those known manuals and checklists of aquatic vascular plants covering the following geographical categories: (1) the conterminous United States, (2) five different regions of the United States, and (3) 16 individual states. A citation of a bibliography on aquatic vascular plants is included for Ohio. The five regions that have aquatic vascular plant manuals essentially cover the entire United States, but not all of these publications are of equal scope with similar objectives, and some are older than others and in need of revision. Certainly more work at the state level is necessary, even in some of those states that already have manuals and checklists. The bibliography presented here gives some idea of the extent and state of knowledge in this science and hopefully will provide a guide for future basic and applied research on aquatic vascular plants. Grateful appreciation will be given for calling overlooked references to my attention.

UNITED STATES

Hotchkiss, Neil. 1967. Underwater and Floating-leaved Plants of the United States and Canada. Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 44. 124 pp. (Reprinted 1972, in combination with the following work, by Dover Publications, Inc., New York, under the title, "Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada.")

Hotchkiss, Neil. 1970. Common Marsh Plants of the United States and Can-

[1] Contribution from the Department of Botany (Paper No. 871) and the Herbarium of The Ohio State University, Columbus, Ohio 43210.

SIDA 6(1): 24—29. 1975.

ada. Bureau of Sport Fisheries and Wildlife, Washington, D.C. Resource Publication 93. 99 pp. (Reprinted 1972, in combination with the previous work, by Dover Publications, Inc., New York, under the title, "Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada.")

Muenscher, Walter Conrad. 1944. Aquatic Plants of the United States. Comstock Publishing Company, Ithaca, New York. 374 pp. (Reprinted 1948, 1964, 1967.)

Prescott, G. W. 1969. How to Know the Aquatic Plants. Wm. C. Brown Publishers, Dubuque, Iowa. 171 pp.

Weldon, L. W., R. D. Blackburn, and D. S. Harrison. 1969. Common Aquatic Weeds. United States Department of Agriculture, Agricultural Research Service, Washington, D.C. Agricultural Handbook No. 352. 43 pp. (Reprinted 1973 by Dover Publications, Inc., New York.)

REGIONAL

CENTRAL UNITED STATES

Lindstrom, Lester Emerald. 1968. The Aquatic and Marsh Plants of the Great Plains of Central North America. Ph.D. Dissertation, Kansas State University, Manhattan. 247 pp.

NORTHEASTERN UNITED STATES

Fassett, Norman C. 1940. A Manual of Aquatic Plants. McGraw Hill Book Company, New York. 382 pp.

Fassett, Norman C. 1957. A Manual of Aquatic Plants. With Revision Appendix by Eugene C. Ogden. University of Wisconsin Press, Madison. 405 pp. (Reprinted 1960, 1966, 1969, 1972.)

NORTHWESTERN UNITED STATES

Steward, Albert N., LaRea J. Dennis, and Helen M. Gilkey. 1960. Aquatic Plants of the Pacific Northwest With Vegetative Keys. Oregon State College, Studies in Botany, Number 11. Corvallis. 184 pp.

Steward, Albert N., LaRea J. Dennis, and Helen M. Gilkey. 1963. Aquatic Plants of the Pacific Northwest With Vegetative Keys. 2nd ed. Oregon State University Press, Corvallis. 261 pp.

SOUTHEASTERN UNITED STATES

Eyles, Don E., J. Lynne Robertson, Jr., and Garnet W. Jex. 1944. A Guide and Key to the Aquatic Plants of the Southeastern United States. United States Public Health Bulletin No. 286. 151 pp. (Reprinted 1963 by Bureau of Sport Fisheries and Wildlife, Washington, D.C. Circular 158.)

SOUTHWESTERN UNITED STATES

Correll, Donovan S., and Helen B. Correll. 1972. Aquatic and Wetland Plants of Southwestern United States. Water Pollution Control Research Series, Environmental Protection Agency. United States Government Printing Office, Washington, D.C. 1777 pp.

THE STATES

CALIFORNIA

Mason, Herbert L. 1957. A Flora of the Marshes of California. University of California Press, Berkeley and Los Angeles. 878 pp.

COLORADO

Matsumura, Y., and H. D. Harrington. 1955. The True Aquatic Vascular Plants of Colorado. Colorado Agricultural Experiment Station, Technical Bulletin 57. 130 pp.

ILLINOIS

Winterringer, Glen S., and Alvin C. Lopinot. 1966. Aquatic Plants of Illinois. Department of Registration and Education, Illinois State Museum Division and Department of Conservation, Division of Fisheries. Illinois State Museum Popular Science Series Vol. VI. 142 pp.

IOWA

Beal, Ernest O. 1952. The Distribution of Aquatic Monocotyledons in Iowa. M.S. Thesis, University of Iowa, Iowa City.

Beal, Ernest O. 1954. Aquatic Monocotyledons of Iowa. Proceedings Iowa Academy of Science (1953) 60: 89-91.

Beal, Ernest O., and Paul H. Monson. 1954. Marsh and Aquatic Angiosperms of Iowa. State University of Iowa Studies in Natural History 19(5): 1-95.

Monson, Paul Herman. 1952. The Marsh and Aquatic Dicotyledonous Flora of Iowa. M.S. Thesis, Iowa State College [University], Ames.

Monson, Paul H. 1954. A Preliminary Report on the Marsh and Aquatic Dicotyledonous Flora of Iowa. Proceedings Iowa Academy of Science (1953) 60: 200-201.

KANSAS

Wilson, James S., and Robert J. Boles. 1967. Common Aquatic Weeds of Kansas Ponds and Lakes. The Emporia State Research Studies 15(3): 1-36.

LOUISIANA

Thieret, John W. 1972. Aquatic and Marsh Plants of Louisiana: A Checklist. Louisiana Society for Horticultural Research Journal 13(1): 1-45.

MICHIGAN

Voss, Edward G. 1966. Checklist of Aquatic Vascular Plants of Michigan. Herbarium, The University of Michigan, Ann Arbor. Mimeographed. 7 pp.

Voss, Edward G. 1967. A Vegetative Key to the Genera of Submersed and Floating Aquatic Vascular Plants of Michigan. The Michigan Botanist 6: 35-50.

MINNESOTA

Carlson, Richard A., and John B. Moyle. 1968. Key to the Common Aquatic Plants of Minnesota. Minnesota Department of Conservation, Division of Game and Fish Section of Technical Services. Special Publication No.

53. 64 pp.

Moyle, John B., and Neil Hotchkiss. 1945. The Aquatic and Marsh Vegetation of Minnesota and its Value to Waterfowl. Minnesota Department of Conservation, Technical Bulletin No. 3. 122 pp.

NEW JERSEY

Essback, Alban R., Donald N. Riemer, and Donald A. Schallock. 1965. Aquatic Vegetation of New Jersey. Part II. Problems and Methods of Control. College of Agriculture, Rutgers—The State University, New Brunswick, Extension Bulletin 382. 98-107.

Fairbrothers, David E., and Edwin T. Moul. 1965. Aquatic Vegetation of New Jersey. Part I. Ecology and Identification. College of Agriculture, Rutgers—The State University, New Brunswick, Extension Bulletin 382. 1-97 pp.

NEW YORK

Clausen, R. T. 1940. Aquatic Vegetation of the Lake Ontario Watershed, pp. 167-187, annotated list, pp. 180-187. *In* A Biological Survey of the Lake Ontario Watershed Supplemental to Twenty-ninth Annual Report, 1939. Conservation Department, State of New York. Biological Survey No. 16 (1939). 261 pp. + maps.

McVaugh, Rogers. 1938. Aquatic Vegetation of the Allegheny and Chemung Watersheds, pp. 176-195, annotated list, pp. 189-195. *In* A Biological Survey of the Allegheny and Chemung Watersheds Supplemental to Twenty-seventh Annual Report, 1937. Conservation Department, State of New York. Biological Survey No. 12 (1937). 287 pp. + maps.

Muenscher, W. C. 1927. Vegetation of Silver Lake and Conesus Lake, pp. 66-67, list of the larger plants, p. 86. *In* A Biological Survey of the Genesee River System Supplemental to Sixteenth Annual Report, 1926. Conservation Department, State of New York. [Biological Survey No. 1 (1926)]. 100 pp. + maps.

Muenscher, W. C. 1928. Vegetation of Cayuga and Seneca Lakes, pp. 243-248, list, pp. 246-248. *In* A Biological Survey of the Oswego River System Supplemental to Seventeenth Annual Report, 1927. Conservation Department, State of New York. [Biological Survey No. 2 (1927)]. 248 pp. + maps.

Muenscher, W. C. 1929. Vegetation of the Niagara River and the Eastern End of Lake Erie, pp. 189-197, list, pp. 195-197. *In* A Biological Survey of the Erie-Niagara System Supplemental to Eighteenth Annual Report, 1928. Conservation Department, State of New York. [Biological Survey No. 3 (1928)]. 244 pp. + maps.

Muenscher, W. C. 1930. Aquatic Vegetation of the Lake Champlain Watershed, pp. 164-185, list, pp. 178-185. *In* A Biological Survey of the Champlain Watershed Supplemental to Nineteenth Annual Report, 1929. Conservation Department, State of New York. [Biological Survey No. 4 (1929)]. 321 pp. + maps.

Muenscher, W. C. 1931. Aquatic Vegetation of the St. Lawrence Watershed including the Grass, St. Regis, Salmon, Chateaugay Systems and the St. Lawrence between Ogdensburg and the International Boundary, pp. 121-144, list, pp. 143-144. *In* A Biological Survey of the St. Lawrence Watershed Supplemental to Twentieth Annual Report, 1930. Conservation Department, State of New York. Biological Survey No. 5 (1930). 261 pp. + maps.

Muenscher, W. C. 1932. Aquatic Vegetation of the Oswegatchie and Black River Watersheds (Including the eastern end of Lake Ontario and the upper stretch of the St. Lawrence River), pp. 199-221, annotated list, pp. 213-221. *In* A Biological Survey of the Oswegatchie and Black River Systems Supplemental to Twenty-first Annual Report, 1931. Conservation Department, State of New York. Biological Survey No. 6 (1931). 344 pp. + maps.

Muenscher, W. C. 1933. Aquatic Vegetation of the Upper Hudson Watershed, pp. 216-238, annotated list, pp. 231-238. *In* A Biological Survey of the Upper Hudson Watershed Supplemental to Twenty-second Annual Report, 1932. Conservation Department, State of New York. Biological Survey No. 7 (1932). 341 pp. + maps.

Muenscher, W. C. 1934. Aquatic Vegetation of the Raquette River Watershed, pp. 209-221, annotated list, pp. 216-221. *In* A Biological Survey of the Raquette Watershed Supplemental to Twenty-third Annual Report, 1933. Conservation Department, State of New York. Biological Survey No. 8 (1933). 301 pp. + maps.

Muenscher, W. C. 1935. Aquatic Vegetation of the Mohawk Watershed, pp. 228-249, annotated list, pp. 242-249. *In* A Biological Survey of the Mohawk-Hudson Watershed Supplemental to Twenty-fourth Annual Report, 1934. Conservation Department, State of New York. Biological Survey No. 9 (1934). 379 pp. + maps.

Muenscher, W. C. 1936. Aquatic Vegetation of the Susquehanna and Delaware Areas, pp. 205-221, annotated list, pp. 216-221. *In* A Biological Survey of the Delaware and Susquehanna Watersheds Supplemental to Twenty-fifth Annual Report, 1935. Conservation Department, State of New York. Biological Survey No. 10 (1935). 356 pp. + maps.

Muenscher, W. C. 1937. Aquatic Vegetation of the Lower Hudson Area, pp. 231-248, annotated list, pp. 240-248. *In* A Biological Survey of the Lower Hudson Watershed Supplemental to Twenty-sixth Annual Report, 1936. Conservation Department, State of New York. Biological Survey No. 11 (1936). 373 pp. + maps.

Muenscher, W. C. 1939. Aquatic Vegetation of Long Island Waters, pp. 88-101, annotated list, pp. 95-101. *In* A Biological Survey of the Fresh Waters of Long Island Supplemental to Twenty-eighth Annual Report, 1938. Conservation Department, State of New York. Biological Survey No. 13 (1938). 128 pp. + maps.

OHIO

Stuckey, Ronald L. 1973. Bibliography of Aquatic Flowering Plants of Ohio. Ohio Biological Survey Informative Circular No. 2. 11 pp.

OKLAHOMA

DeGruchy, James H. B. 1938. A Preliminary Study [and Checklist] of the Larger Aquatic Plants of Oklahoma with Special Reference to Their Value in Fish Culture. Oklahoma Agricultural and Mechanical College Agricultural Experiment Station, Stillwater, Oklahoma. Technical Bulletin No. 4. 31 pp. including 68 figures + one insert [which contains the checklist].

PENNSYLVANIA

Cole, Herbert, Jr., R. G. Wingard, R. L. Butler, and A. D. Bradford. 1967. Aquatic Plants: Management and Control in Pennsylvania. The Pennsylvania State University, University Park. Natural Resource Series Special Circular 79. 32 pp.

SOUTH DAKOTA

Martin, John H. 1965. The Marsh and Aquatic Monocotyledons of South Dakota. Proceedings South Dakota Academy of Science 44: 180-184.

TENNESSEE

Robinson, Franklin D., and Royal E. Shanks. 1959. Checklist of Vascular Aquatic Plants of Tennessee. Journal Tennessee Academy of Science 34: 58-65.

WEST VIRGINIA

Clovis, Jesse F. Without Date. Plants of West Virginia waters. West Virginia Department of Agriculture, Charleston. 15 pp.

TYPIFICATION AND DISTRIBUTION OF THE VARIETIES OF GNAPHALIUM HELLERI BRITTON (COMPOSITAE-INULEAE)

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A study was initiated to elucidate the status of a collection—*Mahler 6850* (SMU)—of *Gnaphalium helleri* Britton taken during a botanical survey of a lake site and strip mining area in northeastern Texas (Mahler, 1973; 1974).

I am indebted to the curators of the following herbaria: FSU, GA, GH, LL, MICH, MO, NCU, NY, TENN, TEX, VDB, Northeastern Louisiana University, Monroe, and University of Southern Mississippi, Hattiesburg. Gratitude is also extended to R. C. Barneby.

KEY TO TAXA

1. Stems white, tomentum loose to dense, obscuring glandular pubescence . . . . . *G. obtusifolium*
1. Stems greenish, not tomentose, visibly glandular . . . . *G. helleri*
   2. Stems glandular-villous; plants of the southeastern United States . . . . . var. *helleri*
   2. Stems glandular-puberulent; plants of the northeastern United States . . . . . var. *micradenium*

GNAPHALIUM OBTUSIFOLIUM L., Sp. Pl.2: 851. 1753.

G. polycephalum Michx.

The white stems of this species possess hairs matted parallel to the stem. Upon removal of the white mat, the glandular-pubescence is usually prominent.

GNAPHALIUM HELLERI Britton

Bull. Torr. Bot. Club 20:280, 1893. LECTOTYPE selected: Northwest, Norfolk County, Virginia, *A. A. Heller s.n.* 23 Sep. 1892, annotated by Britton (NY). SYNTYPES: Northwest, Norfolk County, Virginia, *A. A. Heller s.n.* 23 Sep. 1892 (NY, MO); Southern United States, Georgia, *Boykin s.n.*, annotated by Gray and Britton (NY).

G. polycephalum Michx. var. β, Torr. & Gray, Fl. N. Amer. 2:427. 1843.
G. polycephalum Michx. var. *helleri* (Britt.) Fernald, Rhodora 10: 94. 1908.
G. obtusifolium L. var. *helleri* (Britt.) Blake, Rhodora 20: 72. 1918.

Annuals, aromatic; stems erect, green, pubescence of short, erect, stipitate, glandular hairs or of long, spreading, white, jointed, gland-tipped hairs;

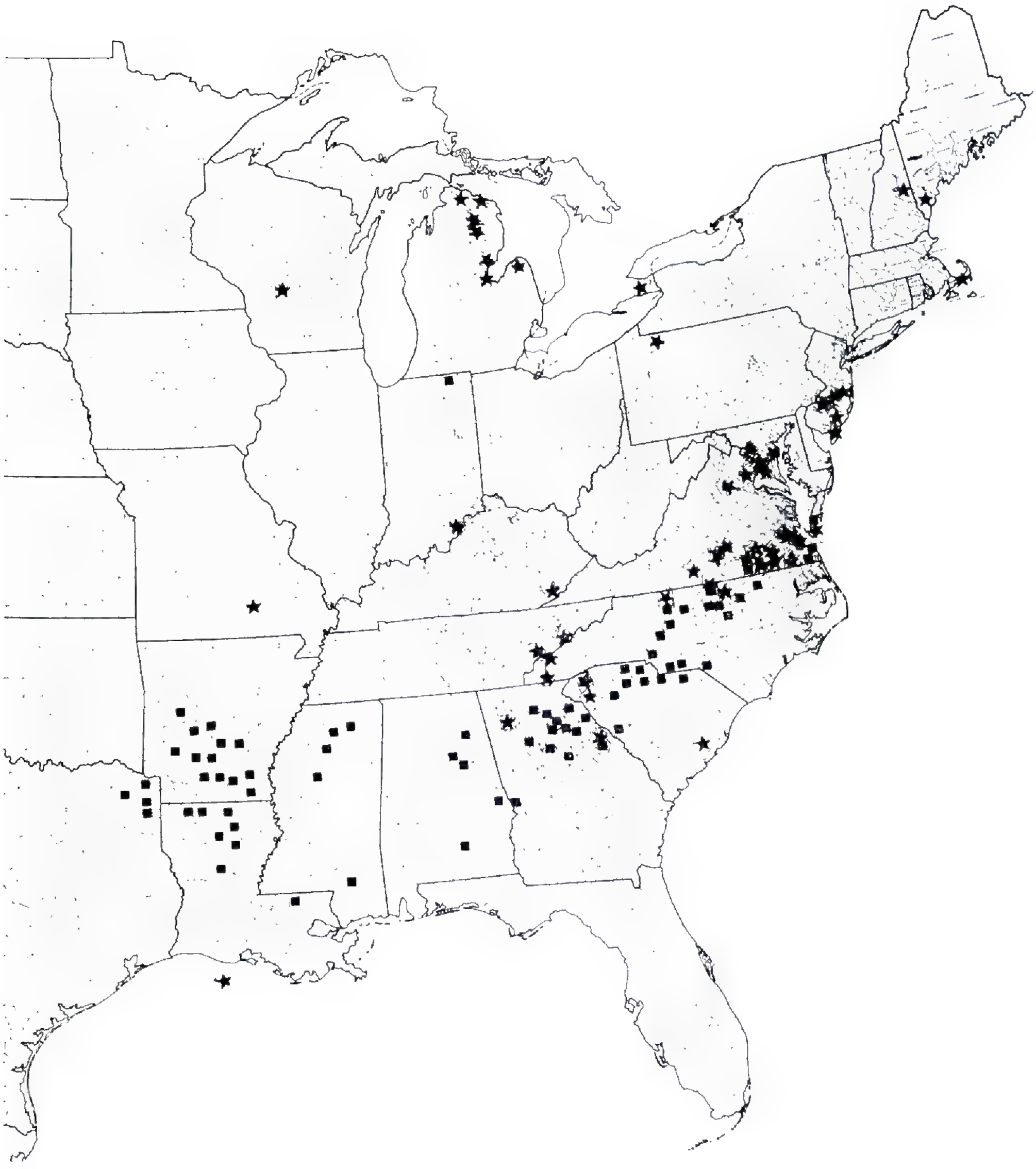

Fig. 1. Documented distribution of *Gnaphalium helleri* Britton: var. *helleri* (squares), var. *micradenium* (stars).

leaves sessile, green and stipitate glandular above, white tomentose to glabrate below, narrowly elliptic, margins entire to undulately toothed; inflorescence of heads in wide to narrow corymbs; heads peduncled, not glomerate at maturity; involucres 7-8 mm long; phyllaries white, rounded to erose apically; achenes brown, glabrous; pappus bristles individually deciduous. Aug.-Nov. Openings and clearings, pine or pine-hardwood forest.

The absence of the white tomentum was regarded as being only of varietal value by Fernald (1908) and Blake (1918). However, the distribution patterns, absence of intermediates, and the conspicuous pubescence patterns result in the recognition of the glandular-viscid taxa as one species.

GNAPHALIUM HELLERI Britton var. HELLERI
Illustrations (photographs); Fernald, Rhodora 38: Plate 434. Figs. 8, 9. 1936.
Distribution Map: Fig. 1.

Main stems and lower floral branches greenish and glandular-villous with spreading, white, jointed, gland-tipped hairs. This variety is well documented in Arkansas (Delzie Demaree collections). Louisiana (R. D. Thomas collections), and the Carolinas (Radford, Ahles, & Bell, 1968). It is probable that this is a result of "disjunct collections" instead of disjunct ranges (Demaree, pers. comm.).

GNAPHALIUM HELLERI Britton var. **micradenium** (Weatherby) Mahler, comb. nov.
G. obtusifolium L. var. *micradenium* Weatherby, Rhodora 25: 22. 1923.
TYPE: Dry, sandy openings among scrub oaks, Barnstable, Mass., 7 Oct 1917, *Fernald 15870* (GH).
Illustrations (photographs): Fernald, Rhodora 38: Plate 434. Figs. 6, 7. 1936.
Distribution Map: Fig. 1.

Stem, pubescence of short, straight, gland-tipped, spreading hairs, not conspicuously whitish or flattened basally. Two specimens examined from Louisiana and western New York did not have specific localities and are plotted adjacent to their respective states in Figure 1.

REFERENCES

BLAKE, S. F. 1918. Notes on the Clayton Herbarium. Rhodora 20: 21-28, 48-54, 65-73.
FERNALD, M. L. 1908. Notes on some plants of northeastern America. Rhodora 10: 46-55, 84-95.
MAHLER, W. F. 1973. Botanical survey of the Lake Monticello area. SMU Contrib. Anthrop. No. 9.
———. 1974. *Gnaphalium helleri* Britton (Compositae - Inuleae) in the Texas flora. The Southwestern Nat. 19: 329.
RADFORD, A. E., H. E. AHLES, and C. R. BELL. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

STUDIES IN THE RANUNCULACEAE OF THE SOUTHEASTERN UNITED STATES. III. CLEMATIS L.[1,2]

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While I was completing a treatment of the Ranunculaceae for the forthcoming *Vascular Flora of the Southeastern United States*, certain nomenclatural and taxonomic decisions were made; these call for additional clarification. This treatment of *Clematis* is conservative in that I am following a species concept allowing for considerable intraspecific population variability. Unless populations show discrete geographic patterns correlated with morphological discontinuities, I see no compelling reason to describe subspecies, varieties, etc. Furthermore, unless breeding studies suggest intraspecific relationships, I prefer to recognize morphologically-defined species. The aim throughout is to provide a rationale for certain taxonomic and nomenclatural conclusions, a key to the species, and data on their distribution in southeastern United States.

Clematis can be distinguished from other genera of Ranunculaceae by its opposite leaves, elongate and generally plumose styles, apetalous actinomorphic flowers, and usually four showy valvate petaloid sepals (Tamura, 1967). I am recognizing 16 species within the southeastern United States (as compared to about 300 species for the world; Buchheim, 1964), an area bounded by and including Louisiana, Arkansas, Kentucky, West Virginia, Maryland, and Delaware.

Aside from the taxonomic treatments by James (1883), Kuntze (1885), and Gray (1895), there have been no recent comprehensive treatments of *Clematis* of eastern North America. On the other hand, in recent years several groups represented in this region have been studied from a critical taxonomic standpoint, e.g., section *Viorna* (Erickson, 1943), the *C. ochroleuca* complex (Wherry, 1931; Fernald, 1943; Keener, 1967), and section *Atragene* in North America (Pringle, 1971). In addition, Fish (1970) studied megagametogenesis in 26 species of *Clematis* (including seven occurring within the southeastern United States) with a view toward examining certain taxonomic and

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[1] Based on a manuscript and notes compiled for the forthcoming *Vascular Flora of the Southeastern United States*. In general, the format follows Radford *et al.* (1967). Any suggestions for improving this treatment should be sent to me so that necessary corrections and additions can be made before the *Vascular Flora* is in press.

[2] Contribution No. 121 from the Department of Biology, The Pennsylvania State University.

SIDA 6(1): 33—47. 1975.

phylogenetic implications from his data. Nevertheless, there is still need for comparative biosystematic studies of the *C. virginiana* group in North America, *C. viorna* and its allies, and *C. crispa*. Moreover, although there are chromosome counts for 10 species (Table 1), counts for six species native to the southeastern United States are still lacking.

Table I. Chromosome Numbers of the Species of *Clematis* in the Southeastern United States.

Species	Chromosome Number	Reference
C. addisonii	$2n = 16$	Gregory (1941)
C..albicoma	$2n = 16$	Keener (1966)
C. baldwinii	$2n = 16$	Keener (1974)
C. catesbyana	no report	
C. coactilis	$2n = 16$	Keener (1966)
C. crispa	$2n = 16$	Gregory (1941), Smith (1965)
C. glaucophylla	no report	
C. maximowicziana	$2n = 16$	Gregory (1941)
(= *C. paniculata* Thunb.,	$2n = 48$	Meurman & Therman (1939)
C. dioscoreifolia Levl.	$n = 32$	Gregory (1941)
& Vaniot)		
C. *occidentalis*	$2n = 16$	Kurita (1956)
(= *C. verticillaris* DC.)		
C. ochroleuca	$2n = 16$	Gregory (1941), Keener (1966)
C. pitcheri	no report	
C. reticulata	no report	
C. versicolor	no report	
C. viorna	no report	
C. virginiana	$2n = 16$	Lindsay (1929), Gregory (1941), Kurita (1958), Bostick (1965)
C. viticaulis	$2n = 16$	Keener (1966)

KEY TO SPECIES

1a. Flowers perfect or imperfect, numerous, in cymose-paniculate inflorescences; sepals whitish, spreading; filaments glabrous 2

1b. Flowers perfect, usually solitary; sepals variously colored, erect to somewhat spreading; filaments pubescent 4

2a. Flowers perfect; leaflets entire, seldom cleft, usually coriaceous; anthers 1.5 mm or more long . . . . . 1. *C. maximowicziana*

2b. Flowers imperfect; leaflets coarsely toothed or lobed, usually membranous; anthers less than 1.5 mm long 3

3a. Leaves 3-foliolate; leaflets usually coarsely serrate, but seldom conspicuously 3-lobed; achenes light to dark brown or greenish brown . . . . . 2. *C. virginiana*

3b. Leaves biternately compound or pinnately 5-foliolate; leaflets often conspicuously 3-lobed or toothed, the lobes entire to coarsely serrate; achenes reddish-brown to dark blackish-purple . . 3. *C. catesbyana*

4a. Sepals thin, slightly spreading, not connivent; leaves ternate; petaloid staminodia sometimes present. . . . . 4. *C. occidentalis*

4b. Sepals thick, usually erect and more or less connivent; leaves simple to pinnately compound; petaloid staminodia absent. 5

5a. Plants erect herbs; leaves usually simple, entire to deeply cleft, seldom all pinnate. 6

5b. Plants climbing vines or scrambling herbs, not erect; leaves commonly pinnately compound. 11

6a. Leaves green and usually pubescent beneath, the uppermost entire, lobed or cleft, neither pinnate nor tendril-bearing. 7

6b. Leaves glaucous and glabrous beneath, the uppermost commonly pinnate and tendril-bearing. . . . . 16. *C. addisonii*

7a. Leaves usually simple and entire, lanceolate to broadly ovate, the largest at least 2 cm wide; mature styles whitish to deep reddish-brown, the longest usually less than 5 cm long; mature peduncles usually less than 20 cm long. 8

7b. Leaves usually variously divided, or, if simple, linear to narrowly ovate, the largest segment or leaf usually less than 2 cm wide; mature styles light yellow, the longest more than 5 cm long; mature peduncles usually more than 20 cm long. . . . . 9. *C. baldwinii*

8a. Leaves of flowering material soft pubescent beneath, the largest 3-9 cm wide, hypostomatic; leaves of fruiting material usually light green with secondary and tertiary veins forming prominent reticulations on the upper surface. 9

8b. Leaves of flowering material scattered pilose to glabrous beneath, the largest 2-5 cm wide, amphistomatic; leaves of fruiting material often dark green with the secondary and tertiary veins not forming prominent reticulations on the upper surface. 10

9a. Stems and leaves villous; sepal backs moderately sericeous-pilose; mature styles yellowish-white to deep tawny, loosely spreading-recurved. . . . . 5. *C. ochroleuca*

9b. Stems and leaves usually densely holosericeous; sepal backs densely holosericeous; mature styles white to pale yellow, sharply recurved and flexuous. . . . . 6. *C. coactilis*

10a. Sepal backs villous; pubescence on carpel margins spreading; mature styles white to pale yellow, sharply recurved and flexous. 7. *C. albicoma*

10b. Sepal backs finely puberulent; pubescence on carpel margins closely appressed-ascending; mature styles tawny to deep reddish-brown, loosely spreading-recurved. . . . . 8. *C. viticaulis*

11a. Leaflets generally coriaceous, the secondary and tertiary veins forming prominent reticulations on the upper surface. 12

11b. Leaflets thin, membranous, the secondary and tertiary veins forming faint or indistinct reticulations on the upper surface. 14

12a. Leaflets green and often soft-pubescent beneath; stem nodes and

rachis joints finely to sparsely pubescent; sepal backs usually sericeous-canescent. 13

12b. Leaflets glaucous and glabrous beneath; stem nodes and rachis joints usually glabrous and glaucous; sepal backs usually glabrous. . . . . 12. *C. versicolor*

13a. Mature styles less than 3 cm long, glabrous or with appressed to spreading villous hairs, not evenly plumose throughout; leaflets generally subglabrous beneath, rarely densely soft-pubescent, more or less coarsely reticulate above. . . . . 10. *C. pitcheri*

13b. Mature styles more than 3 cm long, densely plumose with pilose hairs; leaflets soft-pubescent beneath, rarely glabrate, finely and prominently reticulate above. . . . . 11. *C. reticulata*

14a. Sepals usually (2-)3-5 cm long, dilated distally into thin broad crisped margins up to 6 mm wide; mature styles sericeous, finely appressed-pubescent, rarely evenly plumose; peduncles usually ebracteate. . . . . 13. *C. crispa*

14b. Sepals 1.2-2.5 cm long, the margins tomentose but not dilated distally; mature styles plumose; peduncles usually bracteate. 15

15a. Leaflets greenish and pubescent beneath; stem nodes and rachis joints pubescent; sepal backs finely pubescent. . . . . 14. *C. viorna*

15b. Leaflets glaucous and glabrous beneath; stem nodes and rachis joints glabrous and glaucous; sepal backs usually glabrous. 16

16a. Plants climbing vines; leaves seldom simple, often 6-10 foliolate. . . . . 15. *C. glaucophylla*

16b. Plants erect or ascending; lower leaves simple, upper simple to 2-6 foliolate. . . . . 16. *C. addisonii*

1. C. MAXIMOWICZIANA Franch. & Savat.

Thickets, fence rows, and waste places; widely scattered in pied. and cp., rarely mts. Ala., Ark., Ky., Md., Miss., N.C., S.C., Tenn., Va., W.Va. [Tex., Ill., Pa., N.J.]. *C. dioscoreifolia* Levl. & Vaniot—Fernald (1950), Gleason and Cronquist (1963), Radford (1968); *C. paniculata* Thunberg—Small (1933); incl. *C. d.* var. *robusta* (Carr.) Rehder—Fernald (1950). Cultivated escape; native to Japan.

Even though two widely used names for this species appear in current manuals, nevertheless *C. maximowicziana*, published in 1879 by A. R. Franchet and P. A. L. Savatier (Enum. Pl. Japon. 2: 261), clearly has priority over *C. dioscoreifolia* Levl. & Vaniot (Fedde, Repert. Nov. Sp. 7: 339. 1939; cf. Ohwi, 1965). Furthermore, *C. paniculata* Thunberg (Trans. Linn. Soc. 2: 337. 1794) is preempted by *C. paniculata* J. F. Gmelin (Syst. 873. 1791), a completely different species.

2. C. VIRGINIANA L., Virgin's-bower

Low woods, stream banks, thickets, and waste places; all prov. SE except Del. and Fla. [ALL except Okla. and N.J.].

A comprehensive comparative study of the population variability and breeding behavior of the short-styled virgin's-bowers is sorely needed. Pending such studies, I am recognizing three species, two in eastern North America (*C. catesbyana, C. virginiana*) and one in western North America (*C. ligusticifolia* Nutt.) outside the range covered by this paper. The three species are apparently closely related (Table II; also cf. Fish, 1970) but usually with mature fruiting material they can be distinguished. Nevertheless, intergradient forms occur, especially in Missouri, and, to date, the taxonomy of this complex is not completely clear.

3. C. CATESBYANA Pursh

Low sandy woods, river banks and upland woods; all prov. Ala. mts., Ark. mts., Fla., Ga. cp., Ky. IP., Miss. cp., N.C. cp. and pied., Va. mts. [Mo.]. Incl. *C. micrantha* Small—Small (1933), a small-flowered extreme; incl. *virginiana* L.—Radford (1968), in part; *C. ligusticifolia sensu* Radford, not Nuttall—Radford (1968).

On the basis of leaf and achene characters this species appears distinct (see Table II), even though herbarium material frequently passes as *C. ligusticifolia* or *C. virginiana*. A cytotaxonomic study of this species would be most instructive, especially in respect to its relationship with *C. virginiana*.

Clematis micrantha Small, erected to accommodate small-flowered plants occurring in west peninsular Florida, does not appear to be sufficiently distinct to warrant recognition.

4. C. OCCIDENTALIS (Hornemann) DC., Purple Clematis

Open woods, banks, rocky calcareous slopes and cliffs, rare; chiefly mts. Del. cp., N.C., Va., [Ohio, Pa.]. *Atragene americana* Sims—Small (1933); *C. verticillaris* DC.—Fernald (1950), Gleason and Cronquist (1963), Radford (1968); incl. *C. v.* var. *cacuminis* Fern.—Fernald (1950).

Pringle (1971) in working through the taxonomy of *Clematis* section *Atragene* in North America critically reviewed the nomenclature and persuasively argued that the correct name for this distinctive species is *C. occidentalis* (Hornemann) DC. Pringle also showed that variety *cacuminis*, described by Fernald (1947) to accommodate small-flowering material collected from the Peaks of Otter, Bedford County, Virginia, was actually erected on the basis of immature material. Inasmuch as mature specimens from the same locality do not appear to differ significantly from collections made elsewhere, Pringle therefore regarded var. *cacuminis* as synonymous with *C. occidentalis* var. *occidentalis* (i.e., the wide-ranging eastern North American taxon).

5. C. OCHROLEUCA Aiton, Leatherflower, Curly-heads

Shaded woods, dry open banks and clearings; chiefly cp. and pied. Ga., N.C., S.C., Va. *Viorna ochroleuca* (Aiton) Small—Small (1933).

The eastern short-stemmed leatherflowers (nos. 5, 6, 7, 8; Table III) have been critically studied by Wherry (1931), Fernald (1943), and Keener (1967).

Table II. Comparison of Species in the *C. virginiana* Complex.

Character	*C. virginiana*	*C. catesbyana*	*C. ligusticifolia*
Leaves	3-foliolate	5-foliolate to biternate	Pinnately (3-)5-7 foliolate; rarely biternate
Leaflets:			
color	Usually green to dark green		Pale to yellowish-green
length (cm)	2-10	3-6	(2-)3-6(-8)
shape	Ovate to subcordate	Subcordate to ± lanceolate	Lanceolate to lance-ovate or ovate
margin	Usually coarsely serrate	Usually 3-lobed to entire	Usually coarsely few-toothed or lobed
texture	Membranous		Membranous to coriaceous
pubescence	Glabrous to villous on veins beneath, plus scattered to abundant pubescence over entire abaxial surface		Sparingly strigose on veins beneath, otherwise usually glabrous
stomates	Lower leaflet surface		Upper and lower leaflet surfaces
Peduncles:			
length (cm)	2-6 (avg. :3.9)	3.5-8 (avg. :4-7)	4-7 (avg. :5.3)
pubescence	Glabrous to tomentose; hairs short (0.3-0.5 mm)	Tomentose; hairs short (ca. 0.3 mm)	Villous; hairs both long (0.5-0.7 mm) and short

Table II. Continued.

Character	*C. virginiana*	*C. catesbyana*	*C. ligusticifolia*
Sepals:			
length	Often longer than the fertile stamens		Often shorter than the fertile stamens
shape	Oval to oblong-spatulate	Linear to obovate	Narrowly oblong-lanceolate
Achenes:			
color	Light to dark brown or greenish brown	Reddish or purplish-brown to dark blackish-purple	Light brown to deep reddish-brown
pubescence	Sparingly short pilose to villous hirsute		Densely pilose to crisp hairy
Chromosome number	$2n = 16$	No report	$2n = 16$
Range	Eastern North America	Va. to Ky., south to Ark. and Fla.	Western North America

As a group they are erect herbs (2-6 dm tall) with simple usually entire leaves and with mature fruits having plumose styles less than 5 cm long. Although these plants appear to be closely related, their evolutionary relationships remain relatively obscure (Keener, 1967, 1970). Still, with mature fruiting material, the four species can be determined readily (See Table III).

6. C. COACTILIS (Fernald) Keener

Shale barrens and thin limestone woods, rare; RV. West-central Va.

C. albicoma Wherry var. *coactilis* Fern.—Fernald (1950), Gleason and Cronquist (1963).

This species combines the features of both *C. ochroleuca* (as to vegetative habit and leaf morphology) and *C. albicoma* (fruits) but differs by the pronounced pubescence on the stem, leaves, and sepals (Table III; Keener, 1967). *Clematis coactilis* is a rare species, occurring only in western Virginia, and it may represent a hybrid derivative of *C. ochroleuca* and *C. albicoma* (Keener, 1967, 1970). Until careful breeding studies involving all three taxa are undertaken, the evolutionary relationships of *C. coactilis* will remain obscure.

7. C. ALBICOMA Wherry, Leatherflower

Shale barrens, rare; RV. Western Va. and adjacent W.Va.

This is one of several strict shale barren endemics occurring only on exposed south-facing outcrops of Upper Devonian shales in Virginia and adjacent West Virginia (Keener, 1970). Although *C. albicoma* is relatively distinct from *C. ochroleuca* and *C. coactilis*, it appears to be closest to the extremely rare *C. viticaulis* (Keener, 1967).

8. C. VITICAULIS Steele

Shale barrens, very rare; RV. Western Va.

This species, restricted to only a few shale barrens in Bath and Rockbridge counties in western Virginia, is the rarest *Clematis* in the southeastern United States. It is closest to *C. albicoma* but differs from that species by its finely puberulent sepal backs and usually deep reddish-brown styles (''achene tails'').

9. C. BALDWINII Torrey & Gray

Sandy flat pine woods; cp. Fla. *Viorna baldwinii* (Torrey & Gray) Small—Small (1933).

This distinctive species is restricted to peninsular Florida. Long (1970) pointed out that population studies of *C. baldwinii* would be most desirable, especially to assess leaf shape and sepal size throughout the range. Although he recognized the larger flowered and broader leaved plants as var. *latiuscula*, there appears to be no geographic correlation with respect to the two varieties. Therefore, pending additional field study, I prefer to regard *C. baldwinii* as a unitary polymorphic species.

10. C. PITCHERI Torrey & Gray

Low grounds, woods and thickets; all prov. Ark., Ky. ME. and IP., Tenn. IP. [Tex., Okla., Mo., Ill., Ind.]. *Viorna pitcheri* (Torrey & Gray) Small —Small (1933).

Clematis pitcheri is a wide-ranging mid-central North American species having considerable morphological variability (Erickson, 1943). It enters the western portion of the range, occurring in Arkansas and in western Kentucky and Tennessee. Frequently *C. pitcheri* is confused with *C. reticulata* but the two species are generally readily separable (Table IV).

11. C. RETICULATA Walter

Dry sandy woods and thickets; chiefly cp. and pied. Ala., Ark., Fla., Ga., La., Miss., S.C., Tenn. IP. [Tex.]. *Viorna reticulata* (Walter) Small—Small (1933); incl. *V. subreticulata* Harbison *ex* Small, *V. beadlei* Small—Small (1933).

This variable species occurs throughout the southeastern United States; a thorough population study is needed. There is some variation in the degree of reticulation of the venation pattern on the adaxial surfaces of the leaves, leading Small (1933) to segregate additional species (as *Viorna subreticulata* Harbison *ex* Small, *Viorna beadlei* Small). However, pending further analysis, it seems best to regard *C. reticulata* as a widespread polymorphic species.

Except for its viny habit, *C. reticulata* appears similar to *C. ochroleuca*. Furthermore, *C. reticulata* is confused with *C. pitcheri*, but the two species can usually be distinguished especially with mature material (Table IV). In any case, their ranges generally do not overlap (cf. Erickson, 1943).

12. C. VERSICOLOR Small *ex* Rydberg

Dry rocky woods, bluffs and barrens; all prov. Ark., Ky. IP., Tenn. ME. and IP. [Okla., Mo.].

Clematis versicolor is one of three species of viny *Clematis* having generally pronounced adaxial leaf reticulations. It differs from *C. pitcheri* and *C. reticulata*, however, by having both glabrous and glaucous abaxial leaf surfaces, leaf rachises, and stem nodes (Table IV). Aside from its prominent venation pattern, *C. versicolor* apparently is closely related to *C. glaucophylla* and *C. addisonii*. Both *C. pitcheri* and *C. versicolor* should be carefully studied from a population standpoint, especially in Arkansas.

13. C. CRISPA L., Leatherflower, Blue-jasmine

Low woods, swamps and creek bottoms; chiefly cp. and pied. SE except Del., Md., and W.Va. [Tex., Okla., Mo., Ill.]. *Viorna crispa* (L.) Small—Small (1933); incl. *V. obliqua* Small—Small (1933).

Clematis crispa frequently occurs on the coastal plain and piedmont throughout the southeastern United States. It is readily distinguished by its thin leaves, typically large crisped-margined sepals, sericeous styles, and

Table III. Comparison of Species in the *C. ochroleuca* Complex.[3]

Character	*C. ochroleuca*	*C. coactilis*	*C. albicoma*	*C. viticaulis*
Stem pubescence	Silky pilose	Densely holosericeous	Tomentose to loosely pilose	Usually finely hirtellous
Axillary branches	Seldom overtopping the central axis		Usually overtopping the central axis	
Leaves (fruiting specimens):				
color	± Light green		± Dark green	
shape	Narrowly to broadly ovate		Narrowly ovate to elliptic-lanceolate	
width x length (cm)	3-8 x 4-12	4-9 x 6-11	2-5 x 4-8	2-3.5 x 4-7
pubescence	Soft pubescent beneath		Scattered pilose to glabrate beneath	
texture	± Coriaceous		Membranous to coriaceous	
venation	± Strongly yellowish-reticulate on upper surface		Scarcely yellowish-reticulate on upper surface	
stomates	Lower surface		Both surfaces	
Sepal pubescence (abaxial surface)	Moderately sericeous-pilose	Densely holosericeous	Villous	Finely puberulent
Achene rim pubescence	Strongly appressed-ascending		± Spreading	Closely appressed-ascending

Table III. Continued.

Character	*C. ochroleuca*	*C. coactilis*	*C. albicoma*	*C. viticaulis*
Mature styles:				
color	Yellowish-white to deep tawny	White to pale yellow		Tawny to deep reddish-brown
disposition	± Loosely spreading recurved; heads ± spherical	Usually sharply recurved and flexuous; heads compact, ± flattened		Loosely spreading-recurved; heads ± spherical
Habitat	Shaded woods, dry open banks and clearings; often in soils derived from basic rock	Shale barrens; rarely in calcareous soils	Shale barrens	Shale barrens
Range	Staten Island, N.Y., Va., N.C., S.C., Ga.	Four counties in west-central Va.	Western Va. and eastern W.Va.	Bath and Rockbridge counties, Va.

[3] Based on Keener (1967).

Table IV. Comparison of *C. pitcheri*, *G. reticulata*, and *C. versicolor*.[4]

Character	*C. pitcheri*	*C. reticulata*	*C. versicolor*
Similar features	Vines with ± coriaceous leaflets having a prominent reticulate venation on the adaxial surface		
Node pubescence	Finely to sparsely pubescent		Usually glabrous and glaucous
Leaflets:			
color	Green beneath		Glaucous beneath
pubescence	Glabrous to soft pubescent beneath	Soft pilose to glabrate beneath	Glabrous beneath
shape	Lance-ovate to broadly cordate-ovate	Ovate to elliptical or subcordate	Ovate-oblong to cordate-ovate
apex	± Acute-tipped	Rounded to acute	
venation (adaxial surface)	± Coarsely reticulate	Usually finely and closely reticulate	± Closely reticulate
Sepals:			
abaxial surface	Usually sericeous-canescent		Nearly glabrous
color	Dull purple to dark red	Purplish-red or bluish to pink-lavender	Dull purple to blue lavender
Mature styles:			
length (cm)	1-3 (often broken)	4-6	5-6
pubescence	Nearly glabrous to appressed silky or villous, not plumose	Plumose with pilose hairs	
Range	Ind. to Iowa, s. to w. Ky., w. Tenn., Ark., and Tex.	S.C. to Tenn. and Ark., s. to Fla., Ala., Miss., La., and Tex.	Ky. to Mo. and se. Okla., s. to w. Tenn. and Ark.

[4] Based in part on Erickson (1943).

ebractate peduncles. This species shows considerable variability, reflected by the segregate taxa of earlier workers, e.g. *C. crispa* var. *walteri* (Pursh) Gray, a morph with linear-lanceolate leaflets, and *Viorna obliqua* Small, described as having smaller, scarcely crisped-margined sepals. Although careful study of population variability might reveal definable geographic variants, I am currently treating *C. crispa* as a single polymorphic species.

14. C. VIORNA L., Leatherflower

Rich wooded banks and thickets; all prov. SE except Fla. and La. [Mo., Ill., Ind., Ohio, Pa.]. *Viorna viorna* (L.) Small—Small (1933); incl. *V. gattingeri* Small and *V. flaccida* Small—Small (1933) and *C. v.* var. *flaccida* (Small) Erickson—Fernald (1950).

The wide-ranging *C. viorna* can be distinguished by its viny habit, membranous soft-pubescent leaves, pubescent nodes and leaf rachises, bracteate peduncles, finely pubescent sepal backs, and plumose styles. It is somewhat variable, especially with respect to leaf size and pubescence and sepal size, a fact reflected in two segregate taxa described by Small. *Viorna* (= *Clematis*) *gattingeri* Small, collected from the banks of the Cumberland River near Nashville, Tennessee, was erected on the basis of its smaller flowers and leaflets and glandular pubescence (an incorrect observation by Small; cf. Erickson, 1943). A second species, *Viorna* (= *Clematis*) *flaccida Small* (= *C. viorna* var. *flaccida* (Small) Erickson), was based on plants originally collected in Warren County, Kentucky and that were characterized by their large membranous entire velvety-pubescent leaves. Both species do not appear sufficiently distinctive to warrant taxonomic recognition. Nevertheless, critical population studies of *C. viorna*, especially in central Tennessee and adjacent Kentucky, would be instructive and might reveal more precise taxonomically definable topogamodemes.

15. C. GLAUCOPHYLLA Small

Rich woods and river banks; all prov. Ala., Ark., Fla., Ga., Ky., Miss., N.C., S.C., Tenn. [Okla.]. *Viorna glaucophylla* (Small) Small—Small (1933).

Even though *C. glaucophylla* and *C. addisonii* share the membranous leaflet character of *C. viorna*, they can be distinguished from that species by their glabrous and glaucous leaves, rachis joints, and stem nodes and by their usually glabrous sepal backs. *Clematis glaucophylla* is a rare, morphologically variable species in need of critical biosystematic study, especially in relation to *C. versicolor* and *C. addisonii*. Particularly helpful in this regard would be population studies of the glaucous-leaved leatherflowers from central Tennessee and adjacent Kentucky (cf. Erickson 1943, p. 21).

16. C. ADDISONII Britton

Dry limestone hillsides and wooded banks, rare; RV. West-Central Va. *Viorna addisonii* (Britton) Small—Small (1933).

This very rare species is closest to *C. glaucophylla*. It is quite variable in

habit; e.g., in the same population some plants may be small and erect with only simple leaves, whereas other plants may be more or less viny, up to 1 m long, and with both simple lower leaves and upper 2-6 foliolate pinnately compound ones (Keener, unpubl. data). A critical comparative study of *C. addisonii* with *C. glaucophylla* is required before its taxonomic status can be fully ascertained (cf. Gleason and Cronquist, 1963, p. 319). Pending such analysis, I am retaining *C. addisonii* as a species restricted to dry calcareous hills and banks in a few counties in west-central Virginia.

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REFERENCES

BOSTICK, P. E. 1965. Documented plant chromosome numbers 65: 2. Sida 2: 165-168.

BUCHHEIM, G. 1964. Ranunculaceae, p. 133-137. *In* H. Melchior (ed.), A. Engler's Syllabus der Pflanzenfamilien, Band II, Auflage 12. Gebrüder Borntraeger, Berlin-Nikolassee.

ERICKSON, R. O. 1943. Taxonomy of *Clematis* section *Viorna*. Ann. Missouri Bot. Gard. 30: 1-62.

FERNALD, M. L. 1943. Morphological differentiation of *Clematis ochroleuca* and allies. Rhodora 45: 401-412.

_____. 1947. A new *Clematis* from the Peaks of Otter. Rhodora 49: 219-220.

_____. 1950. Gray's manual of botany, 8th ed. American Book Co., New York.

FISH, R. K. 1970. Megagametogenesis in *Clematis* and its taxonomic and phylogenetic implications. Phytomorphology 20: 317-327.

GLEASON, H. A. and A. CRONQUIST. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand, Princeton, N.J.

GRAY, A. 1895. Ranunculaceae, p. 1-57. *In* B. L. Robinson (ed.), Synoptical flora of North America, Vol. I, pt. 1. American Book Co., New York.

GREGORY, W. C. 1941. Phylogenetic and cytological studies in the Ranunculaceae. Trans. Amer. Philos. Soc., N.S. 31 (pt. 5): 441-521.

JAMES, J. F. 1883. Revision of the genus *Clematis* of the United States. J. Cincinnati Soc. Nat. Hist. 6: 118-135.

KEENER, C. S. 1966. Documented plant chromosome numbers 1966: 1. Sida 2: 434-435.

_____. 1967. A biosystematic study of *Clematis* subsection *Integrifoliae* (Ranunculaceae). J. Elisha Mitchell Sci. Soc. 83: 1-41.

_____. 1970. The natural history of the Mid-Appalachian shale barren flora, p. 215-248. *In* P. C. Holt (ed.), The distributional history of the biota of the Southern Appalachians, Pt. II: Flora. Virginia Polytechnic Inst. and State Univ. Res. Div. Monog. 2.

_____. 1974. IOPB chromosome number reports XLV. Taxon 23: 619-624.

KUNTZE, O. 1885. Monographie der Gattung *Clematis*. Verh. Bot. Vereins Prov. Brandenburg 26: 83-202.

KURITA, M. 1956. Cytological studies in Ranunculaceae. X. Further notes on the karyotypes of *Anemone*, *Cimicifuga*, and *Clematis*. Bot. Mag. (Tokyo) 69: 239-242.

_____. 1958. Chromosome studies in Ranunculaceae. XI. Karyotypes of seven genera. Mem. Ehime Univ. Sect. 2, Nat. Sci., Ser. B, 3(1): 13-22.

LINDSAY, R. H. 1929. The chromosomes of some dioecious angiosperms. Proc. Natl. Acad. U.S.A. 15: 611-613.

LONG, R. W. 1970. Additions and nomenclatural changes in the flora of southern Florida. Rhodora 72: 17-46.

MEURMAN, O. and E. THERMAN. 1939. Studies on the chromosome morphology and structural hybridity in the genus *Clematis*. Cytologia 10: 1-14.

PRINGLE, J. S. 1971. Taxonomy and distribution of *Clematis*, sect. *Atragene* (Ranun-

culaceae), in North America. Brittonia 23: 361-393.
RADFORD, A. E. 1968. Ranunculaceae, p. 452-468. *In* A. E. Radford, H. E. Ahles, and C. R. Bell, Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill, N.C.
RADFORD, A. E., C. R. BELL, J. W. HARDIN, and R. L. WILBUR. 1967. Contributor's guide for the vascular flora of the southeastern United States. Dept. of Botany, Univ. of North Carolina, Chapel Hill.
SMALL, J. K. 1933. Manual of the Southeastern flora. Publ. by the author, New York.
SMITH, E. B. 1965. *In* Documented chromosome numbers of plants. Madroño 18: 122-126.
TAMURA, M. 1967. Morphology, ecology and phylogeny of the Ranunculaceae. VII. Sci. Rep. S. Coll. N. Coll. Osaka Univ. 16: 21-43.
WHERRY, E. T. 1931. The eastern short-stemmed leatherflowers. J. Wash. Acad. Sci. 21: 194-198.

NOTES ON THE FLORA OF THE MOGOLLON MOUNTAINS, NEW MEXICO

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This brief paper begins another "series" of comments on the flora in the southwest, particularly in New Mexico. Voucher specimens have been or will be distributed to various herbaria in the United States. The following comments are about five species of plants in southwestern New Mexico that I have collected and observed during different seasons since 1966.

In the Mogollon Mountains of New Mexico at an elevation of 2760-2470 meters, Indian Creek drains from west to east and flows into Gilita Creek. Only 0.5 km south, Willow Creek converges with Gilita Creek to form the Middle Fork of the Gila River, a major wilderness river of the southwest. The south facing slope of the canyon is forested by *Pinus ponderosa* while on the north facing slope is a mixed coniferous woodland with *Pinus flexilis, Picea pungens, P. engelmannii, Pseudotsuga menziesii,* and *Abies concolor* its major constitutents. Quaking aspen (*Populus tremuloides*) and *Quercus gambelii* become conspicuous angiospermous components of the mixed coniferous woodland.

Numerous small side canyons empty into the main canyon adding to the diversity of habitats that are common in the mountains of the southwest. The canyon bottom (100 meters or more broad in some places) is primarily grassland interspersed with scattered stands of *Pinus ponderosa* and occasional thickets of *Salix* sp. and *Sambucus neomexicana.* The following four species of plants that occur in this canyon are of interest.

ARCTOSTAPHYLOS UVA-URSI (L) Spreng. Up Indian Creek canyon 3 km, and 20 km east of Mogollon on State Highway 78, Catron Co., New Mexico. *Hess 2143* (July 16, 1968). Locally common on either side of the canyon in dense shade under *Pinus ponderosa* or *Picea pungens, P. engelmannii,* and *Pseudotsuga menziesii.*

The collection of *Arctostaphylos uva-ursi* from this canyon extends the range by over 250 km from previous known regions in northern New Mexico. Most likely, other locations of this plant exist in the Mogollon Mountains. It has not been reported from the White Mountains of Arizona and one would expect to find it there. This distribution pattern illustrates two points of interest in southwestern phytogeography. The first would be the absence of data from field investigations on which widely distributed taxa are recorded for either the Mogollon Mountains or the White Mountains respectively, but not from both of the mountain ranges. This often is indicative of our poor knowledge concerning the flora of the region, but it may be these taxa simply

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don't occur in both mountain ranges. The second is the southern extension of some northern Rocky Mountain plants as far south as the Mogollon Mountains and the northern extension of some northern Sierra Occidental plants from Mexico as far north as the Mogollon Range.

The only place in Arizona that *A. uva-ursi* is known to occur is in the Chuska Mountains (McDougal, 1973). These mountains occur in the northwestern and northeastern corners of New Mexico and Arizona, respectively. It has been known from these mountains in New Mexico. In addition, I have examined in the Field Museum, Chicago, a herbarium specimen of *A. uva-ursi* collected by E. A. Goldman in August of 1917 from the Arizona side.

ALLIUM GOODDINGII Ownbey. Up Indian Creek Canyon 3 km, and 20 km east of Mogollon on State Highway 78, Catron Co., New Mexico. *Hess 2181* (July 18, 1968). Locally common in damp and densely shaded floors of some of the north side canyons near their openings into the main canyon.

Previously, *Allium gooddingii* was known only from the White Mountains and Mogollon Rim in Arizona (Dr. Charles Mason, Jr., pers. comm.). Its occurrence in the Mogollon Mountains of New Mexico could be expected. In 1968 at the University of Arizona, I examined the herbarium specimens and labels, and more recently, Dr. Mason has forwarded all the label information on their plants identifed as *A. gooddingii.* From the label information only three main localities in Arizona are indicated, and on one label, concern was expressed by the collector (*Phillips 3600*) that "road re-alignment may destroy this locality." When Ownbey (1947) described this plant, it was known only from the type locality. It now appears that *A. gooddingii* has a wider distribution with the likelihood of finding other sites and consequently a greater assurance that it will be preserved.

SISYRINCHIUM ELMERI Greene. Up Indian Creek Canyon 3 km, and 20 km east of Mogollon on State Highway 78, Catron Co., New Mexico. *Hess 2165* (July 18, 1968). Uncommon, along the creek margin with *Sisyrinchium demissum, Veronica americana, Ranunculus hydrocharoides, Deschampsia caespitosa,* and others.

In the *Arizona Flora* (Kearney & Peebles, 1960), this little plant is called *Sisyrinchium longipes*, and its distribution is recorded as ranging from the San Francisco and White Mountains south into northern Mexico. Bicknell (1900) monographed the yellow flowered *Sisyrinchium* (*Hydastylus*) and our plants correspond well to what is described as *H. elmeri.* The latter taxon was said to occur in the southern California mountains north in the Sierra Nevadas to northern California. Rickett (1970) states that *S. longipes* is equivalent to *S. elmeri.* The range for *S. elmeri* is extended from the mountains of California into Arizona and northern Mexico and now into the Mogollon Mountains of New Mexico.

PEDICULARIS ANGUSTIFOLIA Benth. Pl. Hartw. 22. 1839.

P. angustissima Greene. Leaflts. Bot. Obs. & Crit. 1:151. 1905.

I first collected *Pedicularis angustifolia* during August of 1966 in the Gila

Wilderness on a trail from Willow Creek to Whitewater Baldy and about 20 km east of Mogollon on State Highway 78, Catron Co., New Mexico. *Hess 930.* In the *Flora of New Mexico* (Wooten & Standley, 1915), the plants keyed out to *P. angustissima.* Upon checking the Bebb Herbarium specimens of *Pedicularis* at the University of Oklahoma, none called *P. angustissima* could be found. Further checking uncovered specimens identified as *P. angustifolia,* and it appeared that the plants from New Mexico were the same taxon. I have further checked plants labeled either *P. angustifolia* or *P. angustissima* in various herbaria (US, NY, ARIZ, MICH, F) with the same results, that is, all of the collections from Mexico are labeled *P. angustifolia* and the plants from New Mexico are called *P. angustissima.* Morphologically, the two taxa are indistinguishable and their variation completely overlaps. Green (1905) describes his specimens as "flowers crowded" and "leaves narrowly linear, 2 in. long, callous-crenulate" and Bentham (1839) writes "spicis densis paucifloris" and "foliis anguste linearibus integris margine minute cartilaginco-serrulatis." There seems to be little doubt that the two named taxa are the same, and that the plant collected and named by Greene (1. c.), *P. angustissima,* should be placed in synonymy under *P. angustifolia.*

Pedicularis angustifolia is widespread in the Mogollon Mountains and found mostly in association with *Picea engelmannii.* In these areas at an elevation of approximately 3200 meters, it makes up a dominant portion of the understory. In localities, such as Indian Creek, it is also found on the hillsides in shaded regions of mixed coniferous woodland. This is another plant species that has the major part of its distribution in the mountains of northern Mexico just extending north into the Mogollon Mountains. As far as I know, *P. angustifolia* hasn't been found in Arizona and one would expect to find it in either the White or Chiricahua Mountains.

JUNIPERUS COMMUNIS L. var. DEPRESSA Pursh. On trail from Whitewater Baldy to Mogollon Baldy Mountain, approximately 19 km due east of Glenwood, Catron Co., New Mexico. *Hess 2268* (Aug. 22, 1968).

Although the range extension is not great (only 50 km southeast of the White Mountains of Arizona), Dr. Marion T. Hall (pers. comm.) did think it a significant factor to find it in the Mogollon Mountains. It occurs at an elevation of 3,225 meters under *Picea engelmannii.* This is still another example of the phytogeographic richness of the Mogollon Mountains with respect to the distributional overlap of northern Rocky Mountain plants and northern Sierra Occidental plants of Mexico.

I appreciate the suggestions of Dr. Marion T. Hall, Dr. George Ware, and Mr. Floyd Swink concerning this manuscript.

REFERENCES

BENTHAM, G. 1839. Plantae Hartwegianae. G. Pamplin, London. p. 393.

BICKNELL, E. P. 1900. Studies in *Sisyrinchium* VIII: *Sisyrinchium californicum* and related species of the neglected genus *Hydastylus.* Bull. Torr. Bot. Club 27: 373-387.

GREENE, E. L. 1905. New plants from southwestern mountains. Leaflets Bot. Obs. & Crit. 1: 145-154.

KEARNEY, T. H. and R. H. PEEBLES. 1960. Arizona flora with supplement. Univ. of Calif. Press, Berkeley & Los Angelos, Calif. p. 1085.
MCDOUGAL, W. B. 1973. Seed plants of northern Arizona. The Museum of Northern Arizona, Flagstaff. p. 594.
OWNBEY, M. 1947. The genus *Allium* in Arizona. Research Studies State College Wash. 15: 211-232.
RICKETT, H. W. 1970. Wild flowers of the United States: V. 4: The southeastern states, pt. 1. McGraw-Hill Book Co., N. Y. p. 241.
WOOTON, E. O., and P. C. STANDLEY. 1915. Flora of New Mexico. Contrib. U. S. Nat. Herb. 19: 1-794.

ADDITIONS AND CORRECTIONS TO THE BAHAMA FLORA—II

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Earlier, we presented a compilation of species new to the Bahama flora since the publication (1920) of Britton and Millspaugh's work (Gillis, Howard, and Proctor, 1973), a summary of some nomenclatural changes in the flora from usage in Britton and Millspaugh (Gillis, 1974a), and a union of species resulting from a broader approach to species concepts than employed earlier (Gillis, 1974b). Meanwhile, Correll (1974) and Hill (1974) have reported further new species to the flora. We present here, in the process of preparing a new vascular flora of the Bahama Islands and Turks and Caicos Islands, a compilation of still more additions to the flora, and additional changes in nomenclature from that in Britton and Millspaugh. Voucher specimens for plants reported here for the first time are deposited in the herbaria of the Arnold Arboretum and the Gray Herbarium, and at the Institute of Jamaica.

A D D I T I O N S

POLYPODIACEAE

NEPHROLEPIS MULTIFLORA (Roxb.) Jarrett ex Morton. This Old World fern has become established in the West Indies and South Florida. It differs from *N. exaltata* by its scaly leaves and stem. Moreover, it does not have the ragged frond margins of *N. hirsutula* by which name American populations of it have been called in recent years. Both of these alternative species lack the short hairs on the upper side of the midribs of the pinnae as found in *N. multiflora.*

The species has been found near the abandoned town site of the village replaced by Freeport (Philippi) on Grand Bahama Island (*Gillis 7833*), from Eleuthera (*Proctor 19129*) and Andros (*Proctor 20977).* It has also been found for the first time in South Florida on Key Biscayne at Cape Florida State Park (*Gillis 10856*), although it is probably much more common in the southern part of Florida but has been confused with the other two species mentioned above. The recent publication of the combination for this fern is in the summary of Roxburgh fern types by Morton (1974).

Although Morton claims that New World material identified as *N. multiflora* is actually *N. exaltata,* the first author has seen the two species grow-

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ing together in South Florida where they can be seen to be distinct. Furthermore, most of our Bahama material has been annotated by Dr. Jarrett.

CYPERACEAE

FIMBRISTYLIS ANNUA (All.) R. & S. Populations of this sedge are reported from Andros and New Providence by Kral (1971).

GRAMINEAE

BOTHRIOCHLOA PERTUSA (L.) Willd. This grass was found for the first time in the Bahamas by Dunbar (from Inagua) and reported by Howard and Dunbar (1964) as *Andropogon pertusus*. Since that time, we have collected it on New Providence (*Gillis 11907*) and Grand Turk (*Gillis 11852*). It appears to be spreading rapidly throughout the archipelago. It was not known from the Bahamas at the time of Britton and Millspaugh's writing, nor at the time of Hitchcock's treatment of West Indian grasses (1936). It can easily be distinguished from its congeners by the pit in the middle of the back of the first glume, seen readily by the naked eye. It has been called an *Andropogon* by some (including the second author, GRP) but Gould (1967) preferred placing it in *Bothriochloa*.

LEPTOCHLOA UNINERVIA (Presl) Hitchc. & Chase. We report this species from Inagua (*Proctor* & *Gillis 33930*).

ORCHIDACEAE

Twelve species of orchids are mentioned in Luer's treatment of Florida orchids (1972) as having ranges in the Bahamas. Although we respect the careful work of Luer in drawing up the ranges of his species, we have not been able to find specimens to verify the presence of the following orchids in the Bahamas.

Triphora gentianoides (Sw.) Ames & Schlechter in Ames
Ponthieva racemosa (Walter) Mohr var. *racemosa*
Cranichis muscosa Sw.
Spiranthes cranichoides (Griseb.) Cogn. in Urban
Spiranthes elata (Sw.) L. C. Rich.
Tropidia polystachya (Sw.) Ames
Tetramicra canaliculata (Aubl.) Urban
Cyrtopodium punctatum (L.) Lindl.
Oncidium floridanum Ames
Oncidium luridum Lindl.
Macradenia lutescens R. Br.
Polyrrhiza lindenii (Lindl.) Cogn.

EUPHORBIACEAE

DALECHAMPIA SCANDENS L. This common species of the Greater Antilles and Central America has now been found on North Caicos, where it inhabits roadsides to the east of Bottle Creek (*Proctor* and *Gillis 34039*). From

the stinging hairs often present on the plant, especially the fruits, comes the local name "itchy bush."

ARGYTHAMNIA CANDICANS Sw. Ingram (1967) has found that Britton and Millspaugh misdetermined collections of this species and generally placed them in *A. lucayana*. A native of the Greater Antilles, this species is found throughout the southern islands in the Bahama group, and is evidently migrating northward.

ZYGOPHYLLACEAE

TRIBULUS TERRESTRIS L. This Old World weed, common in eastern United States, has now been found in the village of Conch Bar on Middle Caicos (*Gillis 12298*, *Proctor 34064*). This collection represents a wide disjunction from populations in the United States.

MALVACEAE

MALACHRA CAPITATA (L.) L. This species was growing at the Horse Pond or "waterworks" near Matthew Town, Inagua (*Gillis & Proctor 11713*). The nomenclature of Borssum Waalkes (1966) has been followed here. Populations known as *M. alceifolia* are occasionally segregated from *M. capitata*, depending upon one's species concept in this group.

MALACHRA URENS Poit. Despite the fact that the genus *Malachra* had not previously been reported from the Bahamas, we now have two species represented in the flora. *Malachra urens*, a weedy species, has been found in vacant lots in Nassau, New Providence (*Gillis 11893*).

MALVAVISCUS ARBOREUS var. CUBENSIS Schlecht. Instead of var. *mexicanus* which had been reported from the Islands, Schery (1942) maintained the Bahama populations were this variety of *M. arboreus*.

SIDA CILIARIS var. INVOLUCRATA (A. Rich.) Clement. In his treatment of *Sida*, Clement (1957) has recognized two varieties of this species in the Bahamas. This report of var. *involucrata* is new to the Islands.

STERCULIACEAE

AYENIA TENUICAULIS Urban. Cristobal (1960) indicated that the southern Bahamas have this species in addition to *A. insulicola*. This species differs from *A. insulicola* by its much smaller and nearly orbicular leaves and pubescent ovary and fruits, in addition to shorter ("mamiform") projections from the fruits.

MELOCHIA TOMENTOSA var. FRUTESCENS (Jacg.) DC. In his treatment of *Melochia*, Goldberg (1967) recognized a small-leaved form of *Melochia tomentosa* in the southern islands. This differs in a number of characters from typical var. *tomentosa*. The authors have found it on Mayaguana, Inagua, and in the Caicos Islands.

CUSUTACEAE

CUSCUTA GLOBULOSUS Benth. Yuncker (1965) reported the presence of

this additional species of dodder in the Bahamas on the Cay Sal Bank. This remote cluster of islands at the eastern end of the archipelago has an interesting assemblage of Cuban species in its flora.

CUSCUTA UMBELLATA Kunth. A Proctor collection (No. *8819*) from South Caicos was determined by Yuncker to be this species. We have since found it on Grand Turk (*Proctor and Gillis 34044*).

CONVOLVULACEAE

IPOMOEA NIL (L.) Roth. We suspect that this species becomes introduced to the Bahamas periodically and manages to be collected from time to time and then dies out. It has not been found consistently on any island. An old collection of Wight (No. *130*) from New Providence was found at the Gray Herbarium, apparently not discovered by Britton and Millspaugh when they wrote their flora. Proctor found it once again (No. *30783*) on Andros in a farm area south of San Andros airfield.

BORAGINACEAE

TOURNEFORTIA STENOPHYLLA Urban. This Cuban species has turned up several times on Inagua where it appears to be well established. It was common with *T. volubilis* at Devil's Point (*Proctor 33905*), and was a primary invader on Maroon Hill (*Gillis 12116*) which had been stripped of its soil and upper layers of rock for use as fill.

LENTIBULARIACEAE

UTRICULARIA GIBBA L. Peter Taylor has examined many of the early twentieth century collections upon which B&M based their treatment of *Utricularia* in the flora. He has realigned several of the species names involved. Although true *U. foliosa* is known from the Bahamas (from Grand Bahama Island, *B&M 2679*) as indicated in the flora, most of the species originally named as *U. foliosa* by B&M should instead be called *U. gibba*.

COMPOSITAE

SPILANTHES IODISCAEA A. H. Moore. This tiny composite was found in the dry muck at the bottom of Smith's Thatch Pond on Inagua during the dry season (*Gillis 11738*). It had been found earlier in a pond near Salt Pond Hill on the same island by Dunbar, but unreported in Howard and Dunbar (1964). It is represented by a Dunbar collection at the Arnold Arboretum.

ERIGERON BELLIOIDES DC. Also from Inagua, near Salt Pond Hill, comes this small plant, found by Dunbar (No. *318*), but previously unreported. This, too, is represented by a specimen at the Arnold Arboretum.

C O R R E C T I O N S

For ease of reference this section will follow the order of species presented in Britton and Millspaugh's Flora, which will be Monocotyledons first, followed by the Dicotyledons, and then the Pteridophytes. Again for brevity,

the previous flora is referred to by the expression B&M in the text herein. The number preceding the names refers to the page in B&M on which the taxon in question is discussed. The name in capital letters is the name considered to be correct. These names are not necessarily nomenclatural or taxonomic equivalents, hence the reason for not employing an equals sign (=). In some instances, B&M misidentified the plant or used a binomial incorrectly.

GRAMINEAE

16 *Syntherisma sanguinalis*—DIGITARIA CILIARIS (Retz.) Koeler. As Adams (1972) has pointed out, *Digitaria sanguinalis* (L.) Scop., based on *Panicum sanguinale* L., is not the plant of the West Indies. The two plants differ in a number of ways, however subtle. Ebinger (1962), Gould (1963), and Blake (1969) have noted differences in chromosome number, length of second glume in relation to the length of the spikelet, mean pollen size, presence or absence of spicules on the sterile lemma, and presence or absence of papillose-based hairs on the foliage as the differentiating characters. The West Indian species has long been called *Digitaria adscendens* (HBK.) Henrard, based on *Panicum adscendens* HBK., dating from 1816. *Panicum ciliare* Retz., however is the earliest name for this species (1786) and should be taken up. When placed in *Digitaria*, the combination is *D. ciliaris* (Retz.) Koeler, Descr. Gram.: 27 (1802).

24 In the earlier list of corrections in the flora (Gillis, 1974a), a change was not made properly due to a typographical error. It should have read *Panicum coerulescens*—PANICUM CAERULESCENS Hack. ex. Hitchc.

PALMAE

58 *Thrinax microcarpa*—THRINAX MORRISII H. Wendl. Read (1974) has indicated that this small thatch palm must undergo a name change as the result of proper typtification.

59 *Coccothrinax argentea*—COCCOTHRINAX ARGENTATA (Jacq.) L. H. Bailey. In the earlier treatment of name changes (Gillis, 1974a) a misplaced line of type made nonsense of the attempt to explain this name change. True *C. argentea* may exist in the southern Bahamas, but this has yet to be demonstrated. It is now treated as being indigenous to Hispaniola. The Bahama plant is *C. argentata*.

RANUNCULACEAE

140 *Clematis bahamica*—CLEMATIS DIOICA L. There appears to be no significant difference in these plants. Therefore, the earlier name must prevail.

LEGUMINOSAE

178 *Sophora tomentosa*—SOPHORA TOMENTOSA subsp. BAHAMENSIS Yakovlev. Earlier, one of us (Gillis, 1974a) indicated that all Bahama plants were typical subspecies and we did not recognize the infraspecific taxa of

Yakovlev (1967a and b). We now find that we should follow his treatment, at least in part, in recognizing that the Bahama plants all represent subsp. *bahamensis* instead of the typical subspecies. In this choice, we follow Rudd (1972).

184 In an earlier updating of nomenclature (Gillis, 1974a), an incorrect author citation was attributed to *Desmodium tortuosum*. It should be *D. tortuosum* (Sw.) DC., based on *Hedysarum tortuosum* Sw., Prodr. 1788.

EUPHORBIACEAE

220 *Phyllanthus niruri*—PHYLLANTHUS AMARUS Schum. & Thonn. Webster (1957) has shown that the widespread plant of ruderal sites in South Florida and the West Indies is not *P. niruri* as often named, but rather *P. amarus*.

TAMARICACEAE

279 *Tamarix gallica*—TAMARIX CANARIENSIS Willd. Upon examination of all specimens of this species available to Britton and Millspaugh from the Turks and Caicos Islands, we find that all they had was sterile material! We have been fortunate enough to find a precocious flowering specimen of the population on Grand Turk for specialist Dr. Bernard Baum to study. Our collection (*Gillis 12340*; *Proctor 34094*) was made in June; full flowering in the Turks and Caicos is in July. (Proctor also found it some years ago on South Caicos in flower: *Proctor 8907*). Dr. Baum determined our material to be *T. canariensis* on the basis of papillae on the perianth. The latitude of the Turks Islands is more compatible with *T. canariensis* than *T. gallica*. We are grateful to Dr. Baum for his courtesy in making this determination for us.

FLACOURTIACEAE

285 *Zuelania guidonia*—CASEARIA GUIDONIA (Sw.) Lundell. Lundell (1974) has merged this species of *Zuelania* with *Casearia*. In absence of broadly described generic lines in this difficult family, it seems appropriate to accept this name change until someone performs considerable in-depth studies in the whole family.

HALORAGIDACEAE

311 *Proserpinaca platycarpa* Small—PROSERPINACA PALUSTRIS L. var. PALUSTRIS. It appears that Small's name for a slightly different population in South Florida influenced Britton in his compilation of the Bahama flora. Small's plant is now considered to be quite typical *P. palustris*.

UMBELLIFERAE

313 *Foeniculum foeniculum*— FOENICULUM VULGARE Mill. In making the name change for this species, Gillis (1974a) used the correct new name, but attributed it to the wrong author. The earliest use of this binomial is by Miller in ed. 8 of the Gardener's Dictionary, Art. *Foeniculum*, No. 1, 20 years

earlier than Gaertner's use.

313 *Centella asiatica*—CENTELLA ERECTA (L.f.) Fern. Fernald (1940) recognized that the Old World *Centella* was different from the common, New World species and based his new combination on *Hydrocotyle erecta* L.f., Suppl. 177. 1781. See also Mathias and Constance, 1944.

314 *Helosciadium ammi*—APIUM LEPTOPHYLLUM (Pers.) F. Muell. in Benth. et Muell. The weedy and cultivated plant of the West Indies and most of North America must have its name based on *Pimpinella leptophylla* Pers. (Syn. Pl. 1: 324. 1805) as shown by Mathias and Constance (1944).

SAPOTACEAE

321 MASTICHODENDRON FOETIDISSIMUM (Jacq.) H. J. Lam. In assigning author citations to *M. foetidissimum* in an earlier paper (Gillis, 1974a), the author of the combination was given as Cronquist. The combination, however, was made by H. J. Lam in 1939.

APOCYNACEAE

338 *Cerbera thevetia* L.—THEVETIA PERUVIANA (Pers.) K. Schum. When this commonly cultivated plant is moved from *Cerbera* to *Thevetia*, the transfer of the Linnaean epithet would result in a tautonym. Hence, the use of a later name in *Thevetia*.

SOLANACEAE

382 *Solanum aculeatissimum*—SOLANUM CILIATUM Lam. The plant commonly found in South Florida and the West Indies has the latter name, and not the former. These two species are closely related, but separated by the fact that *S. aculeatissimum* Jacq. is an Old World species with brown fruits and smaller seeds instead of the red fruits and seeds about 4 mm. in diameter of *S. ciliatum*. In fact, Tjaden (1970) has made a strong case for replacing *S. aculeatissimum* Jacq. by the still earlier (1773) name, *S. capsicoides* Allioni.

383 *Solanum nigrum*—SOLANUM AMERICANUM var. NODIFLORUM (Jacq.) Edmonds. Edmonds (in Stearn, 1971) has discussed the break-up of the aggregate species *Solanum nigrum* into smaller species realities. *Solanum nigrum* appears to be a temperate species now fairly widely distributed in both New and Old World. The *Solanum americanum* complex is also widely distributed, chiefly—but not exclusively—in the tropics, with classic Miller and Jacquin specimens having originated from such diverse places as West Virginia and Mauritius. Differences among members of the *Solanum nigrum* complex are subtle, but consistent, and include polyploidy. The following couplet summarizes differences discussed by Edmonds in making distinctions between *S. nigrum* and *S. americanum:*

Corolla 10-18 mm. across; anthers 1.5-2.7 mm. long; fruit often nodding; berries black or green, ovoid, 6-10 mm. across; seeds 1.7-2.4 mm. long;

pollen 27-38μ; sepals usually appressed to fruits; hexaploid (2n = 72) . . . . . *S. nigrum.*

Corolla 5-9 mm. across; anthers 1-2 mm. long; fruit erect; berries black, 5-7 mm. across; seeds 1.0-1.5 mm. long; pollen 19-24μ; sepals well reflexed in fruit; diploid ($2n = 24$) . . . . . *S. americanum*

In *S. americanum,* West Indian and eastern South American plants are usually glabrescent and are interpreted by Edmonds as var. *nodiflorum.* Western South American plants are fairly pubescent and are interpreted by Edmonds as var. *americanum.* Both varieties may be typified by specimens at BM. Our population is *S. americanum* var. *nodiflorum* which is also found in Australia (Henderson, 1974) and New Zealand (Baylis, 1958).

SCROPHULARIACEAE

392 *Agalinus spiciformis*—AGALINUS MARITIMA (Raf.) Raf. According to Pennell's treatment (1929), the plants from the Bahamas fall well within the circumscription of *A. maritima,* an earlier name than *A. spiciformis.* He recognized a large flowered form, var. *grandiflora,* for the Bahama populations.

RUBIACEAE

423 *Spermacoce tenuior*—SPERMACOCE CONFUSA Rendle ex Gillis. Gillis (1974c) validated the publication of Rendle's invalid binomial. Rendle (1936) had neglected to provide a Latin diagnosis which was required at the time of his publication. All populations previously reported from the Bahamas as *S. tenuior* appear to be *S. confusa.* An interpretation by Bacigalupo (1972) would treat *S. tenuior* and *S. confusa as synonyms.*

424 *Galium bermudense*—GALIUM HISPIDULUM Michx. *Galium bermudense* L. is difficult to interpret inasmuch as there is no specimen at the Linnaean Herbarium as is suggested by the way in which Linnaeus wrote the protologue. The two pre-Linnaean names cited in the original description are different species. The Gronovius reference is to *G. pilosum* Aiton, while the Plukenet reference is apparently to the species which we have in our flora. Although one might make a case for taking up one or another of these names and typifying it, tradition since the time of Asa Gray (1878) has been to consider *G. bermudense* to be a *nomen dubium* and eliminate it from consideration. Until and unless someone chooses to resurrect *G. bermudense* L., our plant is best named by the next available binomial, *G. hispidulum* Michx.

We wish to thank Univ. Prof. Dr. F. Ehrendorfer of the Botanisches Institut und Botanischer Garten der Universität Wien for his interpretation of this matter, and for his consent to publish his heretofore unpublished analysis herein. Incidentally, another *Galium* species from Bermuda which might have been confused with Linnaeus's *G. bermudense* is *G. aparine,* representing a binomial of the same date of publication as *G. bermudense.*

COMPOSITAE

435 *Vernonia obcordata*—VERNONIA ARBUSCULA Less.
436 *Vernonia bahamensis*—VERNONIA ARBUSCULA Less.
436 *Vernonia insularis*—VERNONIA BLODGETTII Small.

As has been our inclination with *Aster* (See Gillis, 1974b), we have interpreted the northwestern populations in the islands to be merely extensions of the ranges of southeastern U.S. species, and not endemics to the Bahamas. Thus, we wish to reduce the number of *Vernonia* species in the archipelago. *Veronia insularis* Gleason is synonymous with *V. blodgettii* Small, the latter being the earlier name. *Vernonia blodgettii* occurs in South Florida and the so-called *V. insularis* is simply the Bahama extension of its range. (Our judgment is supported by personal communication with Dr. S. B. Jones and Mrs. S. C. Keeley who have *Vernonia* under study.)

Furthermore, we believe that the only woody *Vernonia* in the Bahamas is *V. arbuscula*. The leaf shape variations which have been used to separate this species into two others in addition to *V. arbuscula* are likely environmentally induced, and are highly variable. Typical *V. arbuscula* as seen in the pinelands of New Providence Island has leaves that are chiefly elliptic to ovate. Farther south in the island chain, especially south of the Crooked Island Passage, the leaves become decidedly spatulate. Then, on Little Inagua (and known from only one collection—the type of *V. obcordata*), the leaves appear larger, nearly obcordate. Whether this specimen represents a single individual variation or is typical of the population on Little Inagua cannot be answered at this juncture for lack of material. Our judgment that these several "species" should be merged into *V. arbuscula* is supported by the observations of Mrs. Sterling Keeley (personal communication) who is presently studying the Vernonias of the West Indies.

The treatment of *Vernonia* herein eliminates two supposed "endemic" species from the treatment of B&M. It is considerably different from the treatment of *Vernonia* in the Bahamas by Gleason (1906).

KEY TO *VERNONIA* IN THE BAHAMAS

1. Annual. . . . . *Vernonia cinerea* (L) Less.
1. Perennial.
   2. Shrub; heads scorpioid, in axils of upper leaves; foliage canescent or tomentose; leaves ovate, elliptic to obovate, spatulate, or obcordate. . . . . *Vernonia arbuscula* Less.
   2. Herb; heads cymose, long-peduncled; foliage glabrous or puberulent; leaves narrow, elongated, broadly linear. . *Vernonia blodgettii* Small.

SUMMARY

We report herein 20 plants new to the Bahama flora, and explain the change of name for an additional 22 species.

REFERENCES

ADAMS, C. D. 1972. Flowering plants of Jamaica. University of the West Indies. Mona, Jamaica. 848 pp.

BACIGALUPO, NELINDA M. 1972. Observaciones sobre algunas especies de los géneros *Spermacoce* L. y *Spermacoceodes* O.K (Rubiaceae). Darwiniana 17: 341-357.

BAYLIS, G.T.S. 1958. A cytogenetical study of New Zealand forms of *Solanum nigrum* L., S. *nodiflorum* Jacq., and S. *gracile* Otto. Trans. Roy. Soc. New Zealand 85: 379-383.

BLAKE, S. T. 1969. Taxonomic and nomenclatural studies in the Gramineae, No. 2. Proc. Roy. Soc. Queensland 81: 1-26.

BORSSUM WAALKES, J. VAN. 1966. Malesian Malvaceae revised. Blumea 14: 1-213.

CLEMENT, I. D. 1957. Studies in *Sida* (Malvaceae). 1. A review of the genus and monograph of the Sections *Malacroideae*, *Physalodes*, *Pseudomalvastrum*, *Incanifolia*, *Oligandrae*, *Pseudonapaea*, *Hookeria*, and *Steninda*. Contr. Gray Herb. 180: 5-91.

CORRELL, DONOVAN S. 1974. Flora of the Bahama Islands — new additions. Fairchild Trop. Gard. Bull. 29: 11-12; 15.

CRISTOBAL, CARMEN L. 1960. Revision del genero "*Ayenia*" (Sterculiaceae). Opera Lilloana iv. Tucuman, Argentina. pp. 5-230.

EBINGER, JOHN E. 1962. Validity of the grass species *Digitaria adscendens*. Brittonia 14: 248-253.

EDMONDS, JENNIFER K. 1971. *Solanaceae* in William T. Stearn: Taxonomic and nomenclatural notes on Jamaican gamosepalous plants. J. Arnold Arbor. 52: 634-635.

FERNALD, M. L. 1940. Spermatophytes of eastern North America. Rhodora 42: 281-302.

GILLIS, WILLIAM T. 1974a. Name changes for the seed plants in the Bahama flora. Rhodora 76: 67-138.

———. 1974b. Phantoms in the flora of the Bahamas. Phytologia 29: 154-166.

———. 1974c. The confused *Spermacoce*. Phytologia 29: 185-187.

———, Richard A. Howard, and George R. Proctor. 1973. Additions to the Bahama flora since Britton and Millspaugh—I. Rhodora 75: 411-425.

GLEASON, HENRY A. 1906. The genus *Vernonia* in the Bahamas. Bull. Torrey Bot. Club 33: 183-188.

GOLDBERG, AARON. The genus *Melochia* L. (Sterculiaceae). Contr. U.S. Natl. Herb. 34: 191-363.

GOULD, FRANK W. 1963. Cytotaxonomy of *Digitaria sanguinalis* and *D. adscendens*. Brittonia 15: 241-244.

———. 1967. The grass genus *Andropogon* in the United States. Brittonia 19: 70-76.

GRAY, ASA. 1878. Synoptical flora of North America. Vol. 2. New York.

HENDERSON, R.J.F. 1974. *Solanum nigrum* L. (Solanaceae) and related species in Australia. Contr. Queensland Herb. No. 16: 1-78.

HILL, STEVEN R. 1974. Range extensions and new records for the Bahama flora. Rhodora 76: 471-477.

HORVAT, SISTER MARY LIGOURI. 1941. A revision of the subgenus *Mariscus* found in the United States. Contr. Biol. Lab. Catholic Univ. Amer. 33: 1-147 + ix.

HOWARD, RICHARD A. and HENRY F. DUNBAR. 1964. Additions to the flora of Inagua, the Bahamas. Rhodora 66: 6-15.

INGRAM, JOHN. 1967. A revisional study of *Argythamnia*, subgenus *Argythamnia* (Euphorbiaceae). Gentes Herb. 10: 1-38.

KRAL, ROBERT. 1971. A treatment of *Abildgaardia*, *Bulbostylis*, and *Fimbristylis* (Cyperaceae) for North America. Sida 4: 57-227.

KUKENTHAL, G. 1935-36. Cyperaceae - Scirpoideae - Cypereae. Pflanzenreich iv. 20: 1-671.

LUER, CARLYLE A. 1972. The native orchids of Florida. New York Botanical Garden. New York, N.Y. 293 pp.

LUNDELL, CYRUS LONGWORTH. 1974. Studies of American plants - vi. Wrightia 5: 23-44.

MATHIAS, MILDRED E. and LINCOLN CONSTANCE. 1944. Umbelliferae. No. Amer. Fl. 28B, Pt. 1: 43-160.

MORTON, C. V. 1974. William Roxburgh's fern types. Contr. U.S. Natl. Herb. 38 (7): 283-396.

PENNELL, FRANCIS W. 1929. *Agalinus* and allies in North America - II. Proc. Acad. Nat. Sci. Philadelphia 81: 111-249.

READ, ROBERT W. 1974. The ecology of the palms. Principes 18: 39-50.
RENDLE, A. B. 1936. *Spermacoce remota* Lam. J. Bot. 74: 10-12.
RUDD, VELVA E. 1972. Leguminosae - Faboideae - Sophoreae. No. Amer. Fl., Ser. II, Pt. 7: 1-53.
SCHERY, ROBERT WALTER. 1942. Monograph of *Malvaviscus*. Ann. Missouri Bot. Gard. 29: 183-244 + 17 pl.
STEARN, WILLIAM T. 1971. Taxonomic and nomenclatural notes on Jamaican gamosepalous plants. J. Arnold Arbor. 52: 614-648.
TJADEN, W. L. 1970. Carlo Allioni and his *Auctarium Ad Synopsim Methodicam Stirpium Horti Reg. Taurinensis*. Taxon 19: 611-616.
WEBSTER, GRADY L. 1957. A monographic study of the West Indian species of *Phyllanthus*. J. Arnold Arbor. 38: 295-373.
YAKOVLEV, G. P. 1967a. Systematical and geographical studies of the genus *Sophora* L. and allied genera. Prob. Pharmacog. 21: 42-62 (in Russian).
. 1967b. Some characteristics of structure of seeds of *Sophora* L. and allied genera in connection with its systematics and phylogeny. Repr. Proc. Leningrad Chem.-Pharm. Inst. 21: 90-98. (in Russian).
YUNCKER, TRUMAN G. 1965. *Cuscuta*. No. Amer. Fl., Ser. III, Pt. 4: 1-51.

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SEX AND THE ANGIOSPERMS—ANOTHER PROPOSITION

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When Dr. John W. Thieret published his thoughtful critique of sex and the angiosperms, I found it stimulating. I have always had an active interest in sex. According to Thieret (1973) we are in error to apply sexual terminology to sporophytic structures of flowering plants. Such terms as "male," "female," and "bisexual flower," for example, are inadmissible because they are "misleading," "inconsistent," "inaccurate," and "superfluous." Instead we should use "staminate" for "male," "carpellate" for "female," and "perfect" for "bisexual."

It was my impression that wherever there are structures and functions related to production of sperms or male gametes, we used the term "male," and of eggs or female gametes, the term "female." I am not quite clear as to what is wrong with this procedure as it applies to angiosperms (or, for that matter, any land plants, or fungi or algae) whether the stage involved is sporophytic or gametophytic.

In vernacular the words "male" and "female" have been commonly associated with forcefulness vs. passiveness, hard vs. soft, yin vs. yang, husband vs. wife, leader vs. follower, inflexible vs. willowy, and so on—largely supposed cultural attributes of man and woman, related to certain kinds of family organization and to formerly accepted traditions for behavior, now, fortunately, being more or less eroded away. In biology, however, the words have a more scientific and precise connotation and pertain to the process of sexual reproduction, which comes down to making sperms and making eggs, as well as caring for embryos and juvenile diploid stages. In people the last is baby care; in higher plants, providing seed coats and endosperm. As soon as "syndromes" of structures and (or) functions become differentiated as part of these basic processes, then they become biologically male and female respectively. Below are listed some examples of such differentiation in the land plants, using two taxonomic groups as illustrations:

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MALE		FEMALE
	FERN	
Microsporophyll		Megasporophyll
Microsporangium		Megasporangium
Microspore		Megaspore
Microgametophyte		Megagametophyte
Antheridium		Archegonium
Microgamete		Macrogamete
	FLOWERING PLANT	
Staminate tree		Pistillate tree
Staminate flower		Pistillate flower
Stamen		Carpel
Pollen sac		Nucellus
Connective		Ovary wall and style
Pollen tube		Embryo sac
Tube nucleus		Polar nuclei

When one is concerned with functional aspects of biology, precise homology of participating parts is traditionally thrown overboard—in my opinion, wisely—in favor of clear expression of roles. The study of analogous structures is one of the most fascinating phases of modern ecological morphology. Thus we have nouns like arm, beak, eye, grazer, herb, leg, predator, tree—words in constant use in biology in writing and speaking but involving all proportions of homology and analogy. If we rid ourselves of the adjectives "male" and "female" in reference to higher plants, we should also include in our house cleaning such familiar adjectives as cortical, carnivorous, embryonic, glandular, pedicellate, pinnate, sessile, vascular, winged, and the like. Should we delete all the words based upon the sexual roots "andr," "gam," "gyn," and "ov?" Is it better that we use "perfect" from some quaint antiquarian concept, or "pistillate," derived etymologically from the word for pestle (strong biological meaning here), or "staminate" from the word for hair or thread (ditto)?

Figure 1 is a diagrammatic representation of the evolutionary advancement of sexual differentiation in vascular plants. The most primitive condition is that in which one kind of spore and one kind of gametophyte is produced. From the time it forms in the sporangium, the spore embodies the ability to produce sex cells of both types, and the entire sexual generation is thus hermaphroditic. In heterosporous pteridophytes, on the other hand, the sex organs are borne upon differentiated gametophytes. The spores producing them are different because of divergent processes operating in the micro- and megasporangia, so that the microsporangia produce only male spores and the megasporangia female. In seed plants, the differences become more and more profound and involve more and more structures. Finally, genetic changes arise that change the sporophytes themselves. Now

EVOLUTION OF SEXUALITY IN VASCULAR PLANTS

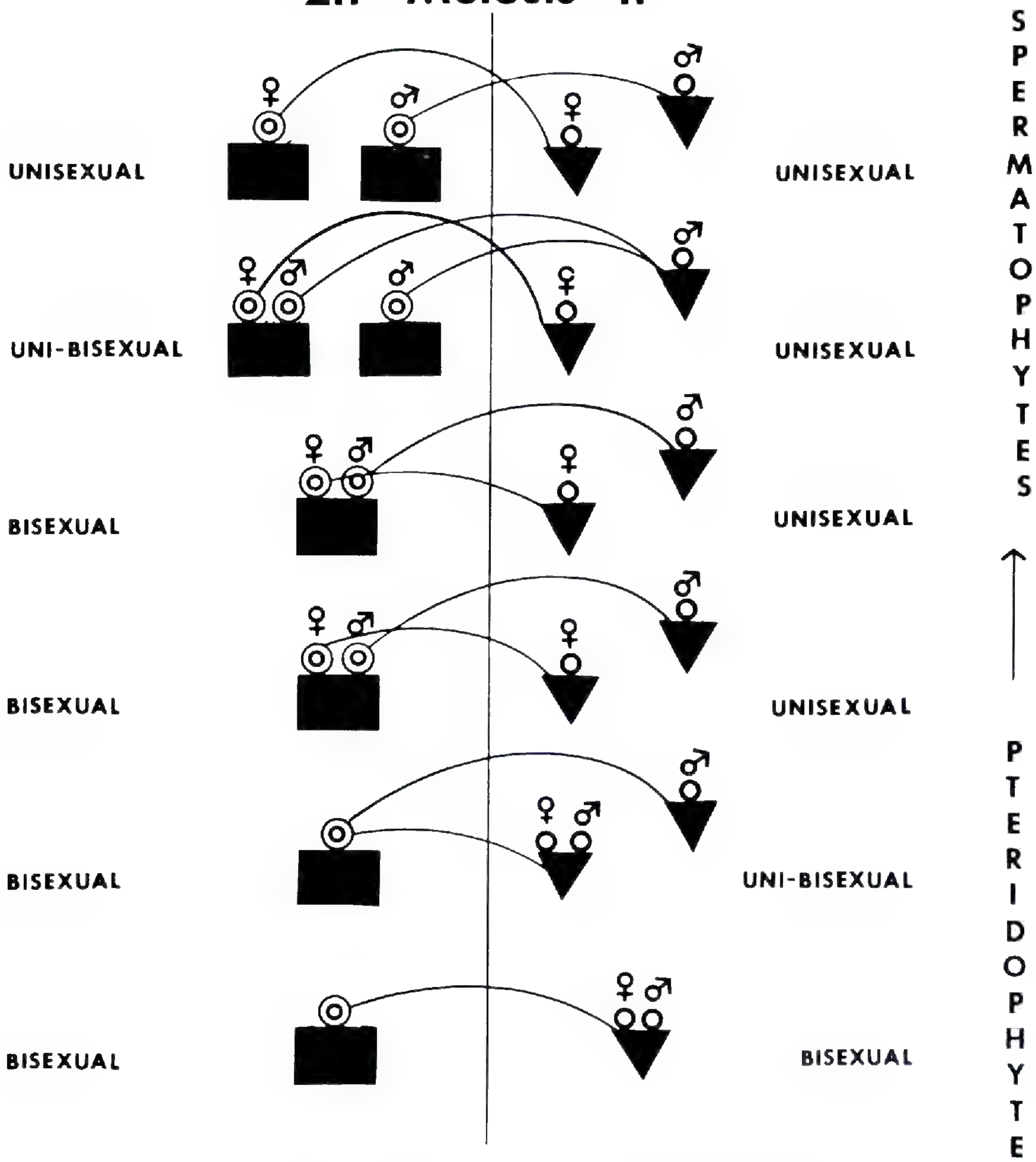

Fig. 1. Diagrammatic representation of the evolutionary advancement of sexual differentiation in vascular plants.

the sexual differentiation has moved into the $2n$ generation, and the staminate plant can produce only sperms and the pistillate only eggs, each utilizing its own now very distinctive structures. In the course of these basic transformations in evolution, we see not only repeated parallels to conditions known in fungi and algae (but surely not homologous, even though they are clearly sexual phenomena), but—what impresses me particularly—beautiful convergences of higher seed plants toward higher animals. It is a remarkable fact that no lower vascular plants are yet known to have evolved sexual differentiation of the sporophytic plant.

In terms of biological strategy, just as the $2n$ scrotum is a male structure, the $2n$ microsporangium is a male structure. Just as ejaculation is a male function in mammals, pollen release is a male function in angiosperms—whether or not the organs involved are homologous. I propose that both words "male" and "female" continue to be used, where appropriate, in connection with vascular plants, and that they be defined as follows:

MALE. Adjective applied to all character-states—diploid or haploid, sporophytic or gametophytic, primary or secondary—adapted to or directly or indirectly correlated with the production and transport of sperms.

FEMALE. Adjective applied to all character-states—diploid or haploid, etc.—adapted to or directly or indirectly correlated with the production and functioning of eggs. Also the structures and functions specifically modified for the protection and nourishment of zygote, embryo, and germling.

As I see them, the advantages of utilizing "male" and "female" in our biological (as opposed to vernacular) terminology are not only in (a) cutting down on polysyllabic verbosity, (b) taking advantage of their obvious meanings, but also—the most important point scientifically—(c) to bring out the remarkable adaptive parallelisms and the universality of "sporophytic" maleness and femaleness, as has evolved separately in higher animals and in higher plants.

To recapitulate, in all probability much of the differentiation into "maleness" and "femaleness" in such diverse groups of organisms as fungi, animals, red algae, and vascular plants constitutes analogy. Nevertheless, the biological functions involved are closely similar in their methods of accomplishment and in their results. Perhaps indeed in some cases the similarities are not so superficial as to some they may seem, for the possibility should be entertained that we are observing homologous genetic potentialities originating in a flagellate common ancestry long since lost in antiquity.

In these terms, a staminate tree of *Salix fragilis*—in spite of its soft and willowy appearance—is just as "male" as a bull, a stallion, or a billy-goat.

REFERENCE

THIERET, J. W. 1973. Sex and the angiosperms. Sida 5: 59-60.

REVISION OF THE RHAMNUS SERRATA COMPLEX

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While I was working on a revision of *Rhamnus* as found in Mexico and southward, my interest was captured by a small group of closely-related species that have narrowish shiny leaves, bud scales, four-merous flowers that are solitary or in axillary clusters of two or three (rarely four) and that tend to be unisexual, and glabrous two-seeded fruits. I call this group informally the *Rhamnus serrata* complex, and I find it especially interesting and exasperating because of the puzzling populations in northern Mexico and western Texas. These are ambiguous, suggesting relationships, on the one hand, to the Coloradan and New Mexican plants called *R. smithii* Greene and, on the other, to *R. serrata* Schult. of the central Mexican highlands. The latest monographer of the group, C. B. Wolf (The North American Species of Rhamnus, Rancho Santa Ana Bot. Gard. Monogr., Bot. Ser. 1: 1-136. 1938) called the plants of Colorado and northern New Mexico *R. smithii* ssp. *typica* and those of southern New Mexico and western Texas *R. smithii* ssp. *fasciculata* (Greene) Wolf. That he did not consider the latter taxon more nearly related to *R. serrata* is apparently a function of the real or fancied geographic proximity of the populations of southern New Mexico to those of northern New Mexico and the fact that *R. serrata* had at that time not been found north of San Luis Potosí. The few poor collections available to Wolf did not reveal a taxonomic problem to him. In the years after Wolf's monographic work, botanical exploration began to show the occurrence of plants of this affinity in several areas of northern Mexico. Collections have been made from a number of mountain masses that, though still leaving some small gaps, very nearly "connect" the central Mexican area with the Rocky Mountain area and reveal the ambiguous taxonomic position of the plants between them (Fig. 1). Examination of about five times as many collections of this complex as were studied by Wolf now suggests that the Mexican *R. serrata* extends in some of its numerous local forms to southern New Mexico and to two localities in Arizona (thus embracing the *R. fasciculata* Greene), but that the northern New Mexican and Coloradan plants are still best treated as a distinct species, *R. smithii*. The latter, in fact, on the basis of length of leaves and petioles, color of leaves beneath, characteristics of the leaf margin, and time of anthesis, seems more closely related to *R. lanceolata* Pursh, a species of lowland forests of eastern United States (Fig. 1).

As will be evident from the following key, and from Wolf's key, the distinctions are tenuous and difficult to put down on paper. One valid alter-

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native to my recognition of several species is to submerge all the members of this complex as varieties of *R. lanceolata*. This would create a wide-ranging and somewhat diverse species such as has been done for the *Prunus serotina* complex (R. McVaugh, Brittonia 7: 279-315. 1951), for the *Ptelea trifoliata* complex (V. L. Bailey, Brittonia 14: 1-45. 1962), and for the *Cercis canadensis* complex (M. Hopkins, Rhodora 44: 193-211. 1942). But on the other hand the species that I recognize here are as well marked as those in other sections of *Rhamnus*, and there appears to be little to gain from the more inclusive approach.

An ancillary problem is presented by *R. standleyana*, based by Wolf on a single collection (*Purpus 4968*) from a seldom-visited mountain range in Coahuila. The general habit of growth and the very small leaves, sometimes fascicled, suggest that this is indeed a distinct taxon. Lending support to this thesis is another specimen from another range in Coahuila (*Johnston 9031*), which seems to me to belong to this category. In other characters (e.g., moderate number of very short almost invisible hairs on both leaf surfaces, yellowish color of undersurface of leaf, and prominent sharp-pointed marginal serrations) these plants appear to be so similar to other members of *R. serrata* that they could be considered a variety thereof. However, until field study and other techniques can be used to clarify the relationships, I do not feel justified in making a new combination for these two specimens and will follow Wolf's nomenclature, as in the following key.

1a. Shrub usually more than 1 m high, the branchlets averaging longer than 1.5 cm and leaves averaging longer than 1.2 cm and not fascicled 2

1b. Small shrubs with branchlets averaging about 1.5 cm long and leaves all under 1.2 cm long, fascicled or tending toward fasciculate. . . . . 4. *R. standleyana*

2a. Stipules quickly deciduous or somewhat persistent but only rarely at leafless nodes, averaging more than 3 mm long; below 3000 m. . . 3

2b. Stipules abundant, persistent even at leafless nodes, averaging less than 3 mm long; Guatemala above 3000 m. . . . . 3b. *R. serrata* var. *guatemalensis*

3a. Branchlets often long, averaging 5 cm or more in length; eastern United States below 1000 m. . . . . 1. *R. lanceolata*

3b. Branchlets shorter; at higher elevations, not in eastern United States 4

4a. Upper surface of leaf gray or olive-green, lower surface paler, rarely yellowish; bud-scales thin, pale; southern Colorado and northern New Mexico . . . . . 2. *R. smithii*

4b. Upper surface of leaf green, lower surface yellowish to brownish, rarely paler green; bud-scales coriaceous, dark reddish; Chiapas northwestward through western Texas, southern New Mexico, and Arizona. . . . . 3a. *R. serrata* var. *serrata*

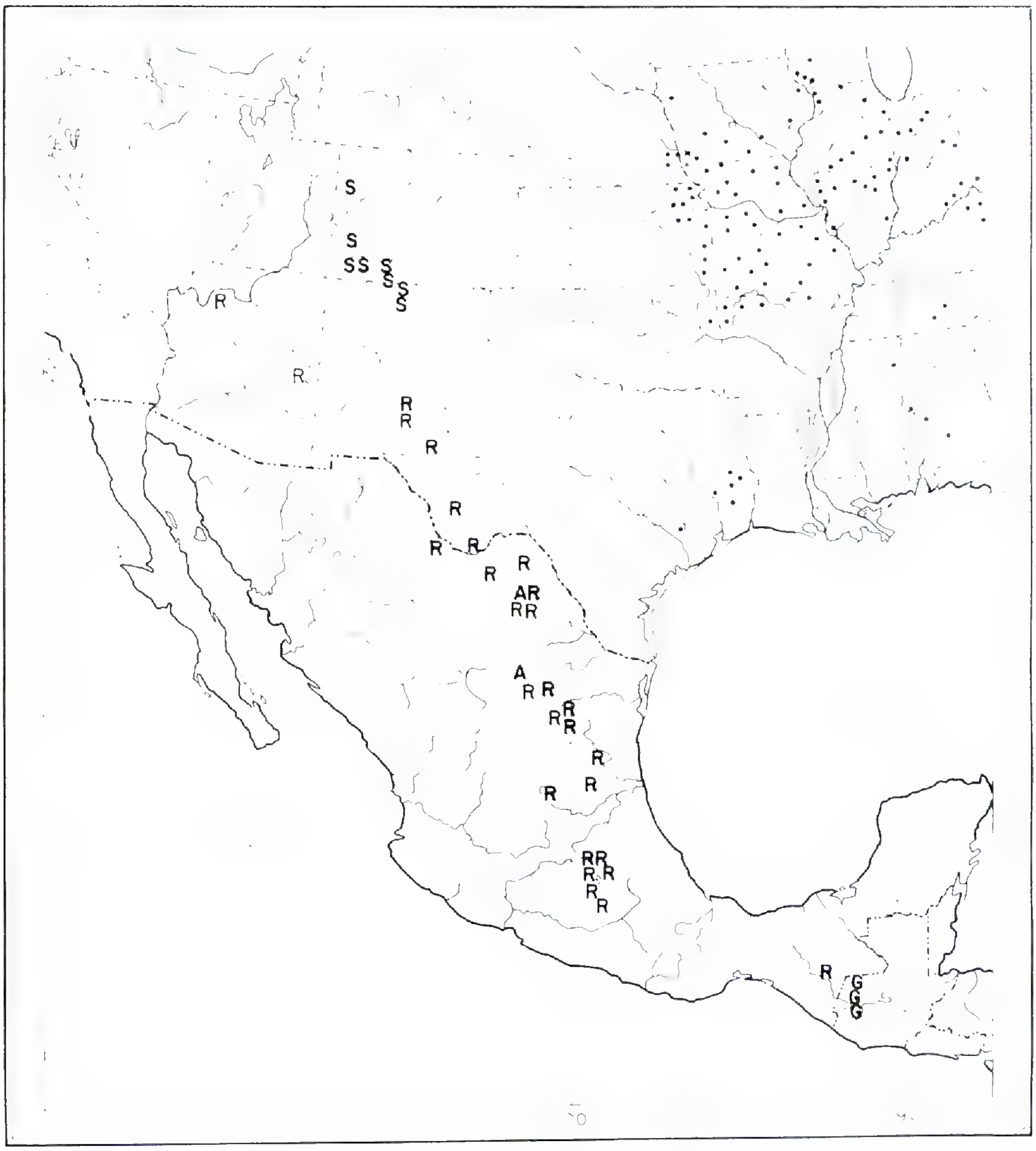

Fig. 1. Documented distribution of members of the *Rhamnus serrata* complex. A, *R. standleyana*; G, *R. serrata* var. *guatemalensis*; R, *R. serrata* var. *serrata*; small dots, *R. lanceolata*, incomplete distribution, the species occurring as far east as Pennsylvania, Maryland, and Virginia.

1. RHAMNUS LANCEOLATA Pursh, Fl. Amer. Sept. 1: 166. 1814.
Sageretia lanceolata (Pursh) G. Don, Gen. Syst. 2: 29. 1832.
Rhamnus shortii Nuttall, J. Acad. Nat. Sci. Philadelphia 7: 91. 1834.
Rhamnus parvifolius Torrey & Gray, Fl. North Amer. 1: 262. 1838.
Cardiolepis nigra Raf., First Cat. Bot. Gard. Transylv. Univ. 18. 1824, nom.; Neogen. 1. 1825; Sylv. Tellur. 28. 1838.
Cardiolepis rubra Raf., Neogen. 1. 1825; Sylv. Tellur. 28. 1838.
Sarcomphalus shortianus Raf., Sylv. Tellur. 29. 1838.

Shrub usually about 2 m high but at times larger, deciduous; bark greenish and sparsely to moderately beset with short hairs when young, reddish and glabrous when older with a thin broken or peeling light-colored outer layer; branchlets frequently long and whip-like with distal leaves larger than proximal and not crowded; bud-scales 1–1.75 mm long and 1–2 mm broad, deltoid, dark reddish, tough and brittle when dried, apically acute or obtuse, with marginal hairs at apex only. Leaves mostly more than 3 cm long when mature, 2–3.5 times as long as broad, at apex acuminate on the large distal leaves through acute on medium-sized leaves to obtuse on small proximal leaves of a branchlet, beneath somewhat paler green than or occasionally the same as above, above and beneath glabrous or with a few hairs which are sometimes visible only when the leaf is at an angle and either short on both surfaces or longer beneath than above; nerves usually glabrous above and with some hairs beneath, and beneath either dark- or light-colored and conspicuous or not; marginally plane (rarely revolute), crenate or occasionally serrate, the teeth (6–)8–18 per cm and with or without dark-colored apexes; leaves thin and easily flexible; petioles (2–)3–6(–8) mm long (longer on type specimen) and usually with hairs only on the margin of an anterior furrow; stipules lorate, 3–5(–6.5) mm long, 0.5 mm broad, pale yellowish, thin and flexible and quickly deciduous. Flowers unisexual, associated with immature leaves, in clusters of 1–3 in the axils mainly of small proximal leaves; pedicels (1–)2–3 mm long, glabrous; floral cup (1–)1.5–2.5 mm deep, 1–1.5 (–2) mm broad, deeper than broad, campanulate or funnelform (rarely hemispheric); sepals 4, ca. (1.25–)1.5–2 mm long, 1–1.25 mm broad, longer than broad; petals 4, ca. 1 mm long and broad (smaller in pistillate flowers), the broad portion gradually narrowing to form a slaw in staminate flowers, broadly notched, uniformly colored; style of pistillate flowers ca. 2 mm long, exserted, bifurcate a fourth its length; filament of staminate flowers ca. 1 mm long, broadly based, the anther small and entirely enclosed by petal in pistillate flowers and partially exposed in staminate ones. Fruit 1–2 usually in axils of small proximal leaves of a branchlet, glabrous, 2-seeded (a few with 3 carpels at an early stage but one aborting), 4–5 mm in diameter (to 7 mm *fide* Wolf), either globose or somewhat prolate, black; pedicels up to 4 mm long, about 1 mm longer than at anthesis; floral cup glabrous and with margin entire or with 2 notches.

In moist wooded areas at less than 1000 m. The map (Fig. 1) shows a rather continuous distribution in the midwestern states but rather large disjunctions in the South. The most striking hiatus, apparently real and not simply the result of inadequate collecting, is from eastern Texas to Alabama and northeastern Oklahoma or northwestern Arkansas, a gap of well over 500 km. The species is unknown in Louisiana and in the southern four-fifths of Arkansas.

Rhamnus lanceolata var. *glabrata* Gleason (Phytologia 2: 288. 1947) seems to be no more than a trivial pubescence form.

TYPE: United States: Tennessee: *Lyon s.n.* (PH!).

REPRESENTATIVE SPECIMENS: United States: Arkansas: *Moore s.n.* (TEX, WIS). Illinois: *Umbach 8349* (TEX, WIS). Indiana: *Friesner 18795* (TEX). Iowa: *Davidson 546* (TEX). Kansas: *McGregor E375* (TEX, WIS). Kentucky: *Short s.n.* (WIS); *Wharton 10844* (NA). Maryland: *Lyon s.n.* (PH). Mississippi: *Ray 8226* (WIS). Missouri: *Hardin 666* (TEX). Nebraska: *Osborn 772R* (MO). Pennsylvania: *Davis 7061* (MO). Tennessee: *Quarterman 4010* (NA). Texas: *Palmer 5180* (US); *Lindheimer 161 = exs. II 228* (MO). Virginia: *Lyon s.n.* (PH).

2. RHAMNUS SMITHII Greene, Pittonia 3: 17. 1896.

Rhamnus smithii subsp. *typica* C. B. Wolf, Rancho Santa Ana Bot. Gard. Monogr., Bot. Ser. 1: 56. 1938.

Shrub 1–2 m tall, deciduous; branchlets (1.5–)2–4(–6) cm long with 6–8(–11) leaves and internodes averaging about 3 mm in length with moderate numbers of short hairs; bark greenish, smooth, with moderate numbers of short hairs when young to grayish and rough and glabrous or sparsely hairy when older and often with a thin, white exterior layer; bud-scales 2.5–6 mm long, pale, flexible, with fimbriate margin and acute or obtuse or notched apex. Leaves 1–1.5 cm long, 0.5–0.6 cm broad on flowering specimens (immature), 4–7.5(–8) cm long, 1.3–2.7(–3.3) cm broad when mature, (2.2–)2.4–2.7(–3.5) times longer than broad, at apex obtuse (usually on smaller leaves) or acute (usually on larger leaves), above gray- or olive-green, beneath paler than or occasionally the same as above or rarely yellowish or yellowish brown on older leaves, on both surfaces glabrous or apparently glabrous with scattered short erect hairs that are invisible when leaf surface is viewed at right angles; nervature above and beneath glabrous or with a few short hairs, beneath dark colored with rare exceptions and conspicuous; margins plane or occasionally slightly revolute, crenate or crenulate with (7–)9–15(–17) usually remote teeth that are apically amber colored to colorless; texture thick or semi-thick and barely flexible; petioles (2–)3–6(–8) mm long with short to medium-length erect hairs usually more heavily concentrated along a ventral furrow; stipules (2.5–)3–4(–5.5) mm long, 0.5 mm broad, pale brownish, membranous, with scattered marginal hairs, quickly deciduous. Flowers associated with immature leaves, 1–3(–4) per axil, either unisexual or protandrous (only appar-

ently staminate flowers seen), pedicels 1.5–2.5 mm long, with sparse to moderate amounts of short, erect hairs; floral cup (1–)1.5–2 mm long, (0.75–)1–1.75 mm broad, longer than broad, campanulate to funnelform, glabrous, dark-colored; sepals 4, 1.25–1.5(–2) mm long, ca. 1 mm broad, longer than broad, glabrous, pale colored; petals 4, ca. 1 mm long, 0.75 mm broad, the broad part gradually narrowing to form a claw, narrowly and acutely notched, mostly uniformly colored or a few with darker-colored upper portion; style bifurcate about half its length; stamens 4, the filaments broad based, each enclosed by a petal, the anthers ca. 0.5 mm long, from half to completely exposed above petal, uniformly yellow; ovary glabrous. Fruit 1–2 per axil of small proximal leaves usually, glabrous, 2-seeded, (3–)4–6(–8) mm long and either globose or somewhat longer than broad, appearing mostly dark brown when dry, the floral parts either absent or a very short portion of the style retained, the floral cup shallow with two notches or less frequently entire and sparsely to moderately beset with short, erect hairs, and pedicels ca. 1 mm longer than at anthesis.

On dry hillsides or along streams usually between 2000 and 2500 m but rarely up to 3000 m. It is known in Colorado and New Mexico (Fig. 1). The report of its occurrence in Arizona (T. H. Kearney and R. H. Peebles, *Arizona Flora*, p. 532, 1951) is based on a specimen now referred to *R. serrata*.

TYPE: United States: Colorado: Pagosa Springs, *Smith s.n.* (PH!)

REPRESENTATIVE SPECIMENS: United States, Colorado: *Andrews s.n.* (PH, US); *Baker 458* (POM, US); *Bethel, Willey, & Clokey 4197* (PH, POM, US); *Brandegee s.n.* (PH); *Cary 172* (US); *Eastwood 17* (POM, US); *Eggleston 14182* (US); *Graham 9709* (US); *Payson 113-7* (TEX); *Tucker 3226* (UCLA); *Vasey s.n.* (US); *Waterfall 15146* & *11710* (RSA); *Weber & Livingston 6333* (RSA, TEX); *Wolf 3082* (RSA, UCLA, US); *Wooton 2899* (US). New Mexico: *Eggleston 6483* & *6566* (US); *Standley 6835* (US).

3. RHAMNUS SERRATA Humb. & Bonpl. ex Schult. in R. & S., Syst. 5: 295. 1819.

Two varieties can be discerned, distinguished by those characters noted in the key; each of the varieties is described and treated below.

3a. RHAMNUS SERRATA Schult. var. SERRATA

Rhamnus serrulata H.B.K., Nov. Gen. et Sp. 7: 51. *t. 617.* 1825.

Rhamnus fasciculata Greene, Leafl. Bot. Observ. Crit. 1: 63. 1904.

Rhamnus smithii subsp. *fasciculata* (Greene) C. B. Wolf, Rancho Santa Ana Bot. Gard. Monogr., Bot. Ser. 1: 58. 1938.

Rhamnus smithii subsp. *fasciculata* var. *mulleri* Fosberg, Lloydia 4: 286. 1941.

Shrub from 1–3(–5) m tall, deciduous or evergreen; bark greenish or when young reddish, grayish or brownish when older with hairs short to long (long only in Texas and most Coahuila collections), mostly erect and straight, of usually moderate amount sometimes glabrate with age (bark

observed to be rough and scaly on a collection from western Texas and several from Coahuila and some from Nuevo León); branchlets (0.6–)0.9–9.5(–12) cm long (the average being about 1–2.5 cm), (4–)6–8(–14) leaves per branchlet; bud-scales 1–2 mm long, coriaceous, dark reddish, with apex broadly obtuse and with hairs dorsally (collections from New Mexico, Texas, and Coahuila) or marginally only (from farther south). Leaves (0.3–)0.5–4(–8.4) cm long with the shorter leaves usually proximal on the longer branchlets or throughout the shorter ones, (0.1–)0.4–1.5(–2) cm broad, from broadly elliptic and ovate (the small leaves, usually) to oblong and lanceolate, at base cuneate to rounded, at apex mostly acute or obtuse (some apexes acuminate in the Chiapas collection; some retuse in a few collections from farther north), above green and in most cases either actually or apparently glabrous (hairs, when present, usually visible only if leaf surface is at an angle to the lens, short and mostly erect), beneath yellowish to brownish (a few New Mexico collections show simply paler green undersurfaces) and either actually or apparently glabrous or with moderate numbers of usually short, erect hairs; nervature above inconspicuous or conspicuously pallid and either glabrous or with variable numbers of mostly short, erect hairs and with midvein hairy and secondary nerves with the same amount of hair or less (rarely glabrous), the hairs erect and of variable lengths; margins revolute or plane (revolute more commonly to the South and plane more commonly to the North), usually serrate but sometimes crenate with (6–)10–15(–17) teeth per cm having apexes all colorless or amber colored or dark and sometimes prominently large; texture from thin and flexible to firm and moderately thick; petioles 1–4(–5) mm long with moderate numbers of short to moderately long erect hairs which may be confined to or concentrated on the margin of a ventral furrow; stipules 2–5(–6) mm long and about 0.5 mm broad, pale-colored (usually reddish) and either thin or moderately thick with sparse to moderate numbers of hairs which may be exclusively on the margin or midvein and either quickly deciduous or somewhat persistent (rarely at leafless nodes). Flowers associated with mature leaves, monoecious or polygamodioecious or protandrous, 1–3 (rarely 4 or 5) per axil; peduncles absent; pedicels usually 3 mm long or shorter (rarely up to 6 mm); floral cups varying in shape from funnelform through urceolate and campanulate to hemispheric (the latter uncommon), (0.6–)1–1.5(–2) mm deep (usually shallower in pistillate than in staminate flowers), 1–2 mm broad, usually broader than deep, glabrous or with sparse to moderate numbers of short, erect hairs; sepals 4, ca. 1–2 mm long, 0.6–1.5 mm broad (usually smaller in pistillate than in staminate flowers), glabrous or with sparse to moderate pubescence; petals 4, ca. 0.5–1.1 mm long, 0.5–1 mm broad at widest part (smaller in pistillate than in staminate flowers), claw apparently more distinct in pistillate flowers, with a notch a fourth to a third the length of the petal, uniformly colored or with the distal portion darker; anther 0.5–0.75 mm long (shorter in pistillate flowers), enclosed by petal partially in staminate flowers and com-

pletely in pistillate flowers. Fruit 1–2 per axil, glabrous, 2-seeded, (3–)4–6(–8) mm broad, either globose or somewhat prolate, pedicels (1.5–)2–4(–6) mm long and with usually moderate pubescence; floral cup with margin circular or split into two parts and glabrous or with short hairs; style sometimes retained.

Found from 1200 to 3000 m.

TYPE: Mexico: *Humboldt & Bonpland s.n.* (B-WILLD No. 4637!)

REPRESENTATIVE SPECIMENS: United States: Arizona: *Hevly s.n.* (ARIZ); *Schroeder s.n.* (ARIZ). New Mexico: *Bailey 454* (US); *Barlow s.n.* (UCLA); *Goodding 6574* (ARIZ); *Eggleston 14361 & 14366* (US); *Hinckley 6567* (ARIZ); *Rehder 427 & 431* (US); *Standley 40687* (US); *Vaughan 1798 & 1799* (ARIZ); *Wolf 2784* (RSA, UCLA); *Wolf 2824* (POM, UCLA, US); *Wooton s.n.* (ARIZ, POM, US); *Wooton 203* (POM, US). Texas, *Correll 29751* (TEX); *Correll & Hanson 29821* (TEX); *Ferris & Duncan 2528* (CA, DS); *Havard 129* (US); *Hinckley s.n. & 985a* (TEX); *Marsh s.n. & 354* (TEX); *McVaugh 7445* (TEX); *Moore & Steyermark 3161* (CA, UC, US); *Palmer 30919 & 31992 & 34337* (US); *Tharp, Warnock, & Hinckley s.n.* (TEX); *Warnock 1023 & 6843 & 12713* (TEX); *Warnock & Tharp 5100 & 6843* (TEX).

Mexico: Coahuila: *Graber 135* (TEX); *Johnston, Chiang, Wendt, & Riskind 11859* (TEX); *Johnston et al. 9393 & 11240 & 11886 & 11924* (TEX); *Marsh 1938* (F, TEX); *Marsh 1389* (F, GH, TEX); *Johnston & Muller 597* (MICH, MEXU, TEX); *Muller 3188* (GH, NA); *Pringle 2810* (GH); *Warnock 11604* (TEX). Chihuahua: *Johnston et al. 10754* (TEX). Tamaulipas: *Sullivan 590* (ENCB, TEX); *Webster 134 & 146* (TEX). Nuevo León: *Johnston et al. 11051* (TEX); *Muller 399 & 455 & 846* (A, F, MICH, TEX); *Muller 1034* (A, TEX); *Muller 2872* (GH, NA); *Taylor 98* (ARIZ, F, TEX); *White 1485* (ARIZ, GH, MICH, US). San Luis Potosí: *McVaugh 10454 & 22161* (MICH); *Palmer 57 & 214* (F, GH, US); *Parry & Palmer 116* (GH, NA, US); *Pennell 17810* (US); *Purpus 5330* (F, GH, MEXU, US); *Rzedowski 4504 & 8050* (ENCB); *Rzedowski 6818* (ENCB, TEX); *Rzedowski 7741* (ENCB, MICH, TEX). Hidalgo: *Chiang ea al. 8128* (TEX); *Rzedowski 22190 & 22937* (ENCB, MICH). State of Mexico: *Ehrenberg 979.6* (US); *Paray 361* (ENCB); *Rzedowski 22021* (ENCB, F, MICH, TEX); *Rzedowski 24180 & 28525* (ENCB); *Rzedowski 28825* (ENCB, MICH); *Uhde 1163 & 1169* (US). Distrito Federal: *Bourgeau 698* (US); *Espinosa 710* (ENCB, TEX); *Pringle 8055* (A, F, MEXU, MICH, POM, US); *Pringle 11947* (F, GH, mixed with *Rhamnus mucronata* Schlecht.); *Paray 1907* (ENCB); *Reiche s.n.* (MEXU, US); *Rose & Hough 4233* (US); *Rzedowski 981 & 2266* (ENCB); *Rzedowski 27245* (ENCB, MICH, TEX). Morelos: *Lyonnet 745.* Chiapas: *Laughlin 1784* (TEX).

3b. RHAMNUS SERRATA Schult. var. **guatemalensis** L. A. Johnst., var. nov.

Frutex 0.3–3 m altus sempervirens cortice modice pubescenti pilis brevibus; ramuli (1.5–)3–9(–16) saepissime ca. 4.7 cm longi arcuati saepe

modice laxi; internodia (0.1–)0.2–1(–1.5) saepissime 0.2–0.3 cm longa; squamae gemmae 1–2 mm longae ferruginosae coriaceae apice late obtusae nonnunquamque incisuratae marginae pubescentes. Folia (0.6–)1–4.2 cm longa (0.3–)0.4–1.2(–1.7) cm lata longissima saepissime 3.07 cm longa 1.32 cm lata parvissima saepissime 1.33 cm longa 0.51 cm lata saepe duplo nonnunquam 3.3-plo raro 3.7-plo longiora quam lata crassiuscula supra nitida pilis modice abundis brevissimis fere invisibilibus raro absentibus subtus fere concoloria glabra vel rarissime pilis brevissimis margine revoluta obtuse serrata crenatave dentibus saepissime introrsis mucronibus praesentibus vel nullis; nervi supra glabri subtus glabri vel pubescentes; costa subtus flavescens; petioli 1–2.5(–3.5) mm longi; stipulae tenues pallidae 2–3.5 mm longae 0.5 mm latae pilis sparsis multis persistentibus. Flores axillares; petalae omnes unicolores. Fructi glabri 2-spermi, pedicelli 2.5–4 mm longi pilis modice abundis brevissimis erecti.

Shrubs 0.3–3 m tall, evergreen (leaves present in December and January collections), bark with moderate amount of short pubescence; branchlets (1.5–)3–9(–16) cm long (averaging about 4.7 cm), with curving habit, generally not very crowded (exception: *Molina 21222*); internodes (0.1–)0.2–1 (–1.5) cm long, most frequently ca. 0.2–0.3 cm long; bud-scales 1–2 mm long, at apex broadly obtuse and occasionally notched, dark rust-red, coriaceous, with marginal hairs. Leaves (0.6–)1–4.2 cm long, (0.3–)0.4–1.2(–1.7) cm broad, the largest averaging 3.07 cm long, 1.32 cm broad, the smallest averaging 1.33 cm long, 0.51 cm broad, mostly twice as long as broad, at times to 3.3 times and rarely 3.7 times as long as broad, thickish, at apex acute, above lustrous with a moderate amount of very short almost invisible pubescence or rarely glabrous, beneath about the same color as above and glabrous or very rarely with short hairs, at margin revolute, bluntly serrate (the teeth introrse, with rare exceptions) or crenate and with mucros present or absent; petioles 1–2.5(–3.5) mm long, with dense pubescence along the ventral suture, sparser pubescence elsewhere with short hairs; stipules thin, pallid, 2–3.5 mm long, 0.5 mm broad, persistent, with scattered hairs. Flowers (only one seen) axillary; petals uniformly colored. Fruits glabrous, 2-seeded (rarely 3-seeded on an otherwise 2-seeded specimen); stigma retained, birfurcate or trifurcate; floral cup retained either circular marginally or notched on two sides; pedicels 2.5–4 mm long with moderate amount of very short, erect pubescence.

In *Juniperus* woods, on rocky slopes and limestone bluffs at 3300 m most frequently but up to 3900 m at times.

TYPE: Guatemala: Huehuetenango: Sierra de los Cuchumatanes, vicinity of Tunima, *Steyermark 48377* (holotype, A!, isotype, F!).

OTHER SPECIMENS SEEN: Guatemala: Huehuetenango: *Johnston 1778* (F); *Molina 21222* (F); *Molina, Burger &, Wallenta 16477* (F); *Standley 81741* & *81769* (F).

4. RHAMNUS STANDLEYANA C. B. Wolf, Rancho Santa Ana Bot. Gard. Monogr., Bot. Ser. 1: 51. 1938.

Small shrub (probably less than 1 m high); bark reddish and fairly smooth, with short hairs; primary branches long; secondary branchlets short, 0.3–0.4 cm long, averaging about 0.6 cm, with (3–)4–12 leaves per branchlet; internodes 0.1–0.6 mm long or leaves tending to be fascicled; bud-scales minute and brown. Leaves 0.3–1.2 cm long, 0.2–0.5(–0.7) cm broad, about 1.5 to 2.5 times as long as broad, thickish, at apex obtuse or tending to be obtuse, above green, beneath yellowish, above and beneath with moderate amounts of very short pubescence that is almost invisible when leaf is flat, at margin plane and serrate with teeth that are antrorse and slender and apically sharp-pointed and colorless; nervature with short hairs; petioles 1–2 mm long with moderate amount of short pubescence; stipules quickly deciduous. Flowers unknown. Fruit solitary in the leaf axils, glabrous, 2-seeded, ca. 6 mm in diameter, the retained portion of the floral cup with scattered short hairs and entire margin; pedicels 2–4 mm long with scattered short hairs.

Found from about 2500 to 3000 m in limestone sierras.

TYPE: Mexico: Coahuila: Sierra de la Paila, *Purpus 4968* (F, GH, US)

OTHER SPECIMEN SEEN: Mexico: Coahuila: *Johnston 9031* (GH).

DISCUSSION

In a species with as large a range as *R. serrata*, morphological and other diversity can be expected. I have delimited only two varieties, but I shall discuss certain geographic patterns and show affinities with the other species treated in this paper.

In the first place *R. smithii* and both varieties of *R. serrata* comprise shrubs usually 1–3 m tall, but shrubs up to 4–5 m have been recorded by collectors in San Luis Potosí and Hidalgo, although this great stature does not seem to correlate with any other distinctive features. *Rhamnus standleyana* is evidently shorter than 1 m. It appears that plants from Texas northward are deciduous and from Mexico southward are evergreen. Observations suggesting the former are (a) the lack of winter or early spring collections from Texas, New Mexico, and Colorado, (b) a collection (*Correll 29751*) in mid-June at a high elevation in western Texas ("base of ledge below Emory Peak") with flowers all in bud and leaves immature both in texture and size, and (c) the presence of only very young immature leaves on early spring collections of *R. lanceolata*. Evidences of the evergreen condition are (a) a spring collection (*Webster 146*), a March collection (*Rzedowski 22021*) and a January collection from the Federal District (*Pringle 8055*) all with large leaves along a primary axis (presumably from the previous year's growth) and secondary axes, shorter and with smaller leaves arising from its axils (presumably from the current year's growth), (b) December and January collections from Guatemala with intact leaves. I found only one exception to this pattern, viz. a February collection from the state

of Mexico (*Rzedowski 28825*) having only small (immature?) leaves along with flowers that are almost all in bud stage. Wolf (Rancho Santa Ana Bot. Gard Monogr., Bot. Ser. 1: 55. 1938) attributed the deciduous character to *R. smithii* (sensu latiore, including *R. fasciculata*, which I now place under *R. serrata*); he claimed that everything he referred to *R. serrata* was evergreen. However, because we are dealing with plants some of which are found in the temperate zone where strong sasonal changes may affect this character and others are found in tropical mountains where the major seasonal change is from wet to dry, I am unwilling to base taxonomic distinctions on the character expression of deciduous versus evergreen.

Based on averages and appearances, *R. serrata* has longer branchlets at the southern end of its range and shorter branchlets at the northern end; but taken individually, the collections do not always fall into neat categories. For instance, *most* Coahuila and Texas collections have branchlets not exceeding 5 cm in length, but in five cases out of 18, there are branchlets exceeding 7 cm in length and even up to 11 cm in one case. At the southern end of the range, in San Luis Potosí, branchlets of 5 cm are quite common and roughly half the collections have branchlets of 8 and 9 cm and even up to 12 cm in length; but in the Federal District and state of Mexico, although 5 cm is a rather common length, only one collection has branchlets exceeding 6 cm in length (*Espinosa 710* has branchlets ca. 15 and 30 cm in length and therefore in this respect resembles *R. lanceolata* more than it does *R. serrata*). Therefore, although a tendency can be seen in branchlet length, it is not correlated sufficiently with other characters or localized enough geographically to permit its use in the infraspecific taxonomy.

Because of the superficial appearance of greater crowding of leaves in the two collections (*Hinckley s.n.*) from Mt. Livermore in the Davis Mountains of western Texas and in a group of Coahuila collections, as compared with otherwise similar collections from the Big Bend National Park, Texas, internode length was measured, but the findings were inconclusive. Throughout the range from Chiapas to New Mexico, the most numerous measurements were 1–4 mm, the next most numerous were 5–9 mm and the least numerous were 10–20 mm. The longest internode lengths, as expected, are found in general on the longest branchlets.

Leaf sizes of collections from Mexico, Texas, and New Mexico reveal that *Muller 3188* and *2872* (described by Fosberg as *R. smithii* subsp. *fasciculata* var. *mulleri*), two Rzedowski collections from Hidalgo, and *Espinosa 710* from the Federal District are the only ones with any leaves exceeding 5 cm in length. In this respect they are like *R. smithii* of Colorado and *R. lanceolata* but not like the smaller-leaved plants of Texas and southern New Mexico that Wolf calls *R. smithii* subsp. *fasciculata*. But leaf-size data alone and as a whole do not support segregation of these collections from *R. serrata*. The two Rzedowski collections from Hidalgo have leaves as much as five times as long as wide but the others (notably *Muller 3188* and *2872*) have leaves about 2.5 times as long as wide, a common proportion for

medium-sized leaves throughout the range. Also common is that leaves which measure less than 1 cm are usually 1–1.5 times as long as broad (rarely up to 2.8 times) and are usually proximal on longer branchlets and exclusive on shorter ones. In general, therefore, for *R. serrata* as a whole, there is a gradual decrease in ratios of length to width from upper to lower extremes in length of leaf.

A specimen from New Mexico (*Goodding 6574*) and one from Arizona (*Schroeder s.n.*), which belong to *R. serrata* on the basis of geographic locality, leaf size, and dark-tipped petals, lack the yellowish or brownish coloration of the leaf undersurface. In this respect, they are more like *R. smithii* and *R. lanceolata*.

In the original description of *R. serrata*, the leaves are said to be glabrous. Actually, hairs in variable densities and lengths can sometimes be found, and some degree of geographic correlation can be seen. The undersurface beneath is glabrous in Chiapas, state of Mexico, Hidalgo, Tamaulipas, most Nuevo León, and some Coahuila specimens. Pubescence is sparse to moderate in a few collections from Nuevo León and in most from Coahuila, Chihuahua, Texas, and New Mexico. Long and fairly abundant hairs are common on both surfaces in Texas collections. Such hairs are otherwise found only on the undersurfaces of a few collections from northern Mexico. On the uppersurface, short hairs are common in New Mexico, Nuevo León, and Coahuila collections and in the solitary collection from Chiapas, while hairs are absent commonly in Tamaulipas, San Luis Potosí, the Federal District, and Morelos.

There is some evidence of a geographic gradient in pubescence of nervature of the leaf upper surface. Most collections from the state of Mexico have glabrous nerves. Both glabrous and hairy nerves can be found in San Luis Potosí and Nuevo León, and only hairy ones in Coahuila, Texas, and New Mexico. Tamaulipas and Chihuahua collections apparently fall into the latter category but they are too few for certainty.

Apexes of marginal teeth are exclusively colorless in all collections from the Federal District, state of Mexico (except from *Espinosa 710*), Hidalgo, and San Luis Potosí (except *Pennell 17810)* and in one collection from Tamaulipas, one from Nuevo León, and one from Coahuila. They are amber colored in most New Mexico collections, in that respect resembling *R. smithii*. Dark-colored apexes are seen in all other collections, including the one from Chiapas.

In general, stipule length averages shorter in the northern part of the range and longer from Nuevo León southward, but great variability and overlap occurs, and the character is considered insignificant taxonomically.

Pedicel length of 1–3 mm at anthesis is essentially uniform for all four species with only two exceptions, *Sullivan 590* from Tamaulipas and *Rzedowski 7741* from San Luis Potosí, which have pedicels measuring 4–6 mm. There is no constant distinction between staminate and pistillate flowers in this character.

Because I am defining *R. smithii* and *R. serrata* differently from Wolf,

something must be said about the floral characters that he tried to use to distinguish these two species. According to Wolf, the petals of *R. smithii* are uniformly colored whereas in *R. serrata* they have dark tips. I find exclusively unicolored petals only in *R. lanceolata* and in *R. serrata* var. *guatemalensis*. Otherwise the findings are as follows. *Gooddings 6574* from New Mexico has dark-tipped petals. *Schroeder s.n.* from Arizona has some dark-tipped and some unicolored petals on the same branch. Among the Texas collections, *Palmer 34337* (pistillate) and *Correll 29751* (staminate) have unicolored petals, *Moore & Steyermark 3161* (staminate; cited by Wolf) has dark tips gradually fading into paler claws, and *Palmer 30919* (staminate) has the blade somewhat darker than the claw. Among the Mexican collections, some have both unicolored and dark-tipped petals on the same plant with some petals mottled, including *Johnston et al. 11240* (staminate), *Sullivan 590* (staminate), *Rzedowski 7741* (staminate), *Pringle 8055* (staminate and pistillate; cited by Wolf), *Rzedowski 2266* (staminate), *Paray 1907* (staminate), and *Ehrenberg 979.6* (staminate, cited by Wolf). Other Mexican collections (e.g., *Johnston et al. 10754*) have petals unicolored or with the tip only slightly darker than the claw; and still others have all unicolored petals, including *Graber 135* (pistillate), *Muller 455* (staminate), *Purpus 5330* (pistillate, difficult to interpret; cited by Wolf), and *Rzedowski 22190* (staminate and pistillate branches). There is slight evidence for a sex correlation from the foregoing data. Female flowers may always have unicolored petals, but male flowers may have either unicolored or dark-tipped petals. The small size of the sample precludes a definitive decision at this time.

Another of Wolf's statements bears rather full discussion. He attributed only unisexual flowers to *R. smithii* (including the New Mexico and Texas populations), and "apparently perfect" ones to *R. serrata*. My own observations suggest that the flowers of all these plants are unisexual. It is possible that they may be protandrous, but the following observations (based on all the flowering specimens of *R. smithii* and *R. serrata* seen) suggest otherwise to me. The apparently staminate flower (judging from the pollen present on the anthers and the small size of the pistil) has the following character-expressions: (a) anther only partially enclosed by the petal, (b) anther 0.5–0.75 mm long, (c) filament 0.5–1 mm long, (d) floral cup 1–2 mm deep, (e) sepals as much as 2 mm long and 1.5 mm broad at base, (f) petals more often dark-tipped than in pistillate flowers, (g) petals 0.6–1.1 mm long and wide, and (h) petal claw broad and indistinct. On the other hand, the apparently pistillate flowers (judging from the well developed pistil and very small anthers) show the following: (a) anther completely enclosed by petal, (b) anther only 0.25 mm long, (c) filament about 0.2 mm long, (d) floral cup 0.6–0.75 mm deep, (e) sepals not exceeding 1.5 mm long and 1.2 mm broad at base, (f) petals more often than not uniform in color, (g) petals only 0.5–0.6 mm long and wide, and (h) claw narrow and distinct. The sample may not have been large enough to serve as a basis for firm conclusions, but the evidence is certainly suggestive.

TAXONOMY OF THE LYTHRACEAE IN THE SOUTHEASTERN UNITED STATES[1]

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ABSTRACT. Keys, distributions, and taxonomic and nomenclatural notes are given for seven genera and 16 species of Lythraceae occurring in southeastern United States. Changes in the treatment of southeastern Lythraceae include recognition of the adventive ROTALA INDICA (Willd.) Koehne in Louisiana, uniting of AMMANNIA TERES Raf. of the United States with the Caribbean A. LATIFOLIA L., acceptance of the monotypic genus DIDIPLIS, and presentation of evidence for uniting LYTHRUM ALATUM Pursh and L. LANCEOLATUM Ell. as LYTHRUM ALATUM var. LANCEOLATUM (Ell.) T. & G. ex Rothrock, a previously overlooked combination. The chromosome number of CUPHEA GLUTINOSA Cham & Schlect. is reported for the first time.

INTRODUCTION

This paper is an outgrowth of a floristic treatment of the Lythraceae written for a proposed *Vascular Flora of the Southeastern United States*, edited by A. E. Radford. Although the Lythraceae are represented in southeastern United States by only seven genera and 16 species, *Ammannia*, *Didiplis*, and *Lythrum* presented taxonomic problems requiring investigation beyond the geographical boundaries of the flora. The treatment of these genera therefore is more detailed than that of the rest of the family.

The curators of the following herbaria are gratefully acknowledged for loan of the material indicated: all Lythraceae, ALU, LAF, LTU, TENN, UNC, MISS, VDB, WVA; *Lythrum*, A, GA, GH, MO, TEX, and US; *Ammannia*, A, GH, MO, TEX, US, and WIS. I also wish to thank the many botanists who shared freely their special knowledge or gathered living material for me. These include Loran Anderson, Delsie Demaree, Joseph Ewan, Samuel Jones, Elizabeth Shaw, John W. Thieret, and Daniel Ward. I am indebted to Robert Ornduff for his helpful comments on the manuscript.

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[1] Based on manuscript compiled for the *Vascular flora of the southeastern United States*. The area covered is bounded by and includes Delaware, Maryland, West Virginia, Kentucky, Arkansas, and Louisiana. The format of the descriptions and method of citing distribution and synonymy basically follows Radford *et al.* (1967). Letters following synonyms cited at the end of species descriptions refer to the following recent floras of the eastern United States in which those names are used: S — Small, J.K., *Manual of the southeastern flora*, 1933; F = Fernald, M.L., *Gray's manual of botany*, 8th ed., 1950; G = Gleason, H.A. and A. Cronquist, *Manual of the vascular plants of the northeastern United States and adjacent Canada*, 1963; R = Radford, A.E., H.E. Ahles, and C.R. Bell, *Manual of the vascular flora of the Carolinas*, 1964.

SIDA 6(2): 80–103. 1975.

LYTHRACEAE Loosestrife Family

Herbs, shrubs, or small trees with quadrangulate or terete stems. Leaves simple, entire, decussately opposite, seldom alternate or whorled, exstipulate. Flowers perfect, regular or irregular; bracteoles 2, opposite on the pedicels; floral tube campanulate to cylindrical, persistent; calyx lobes 4–6, generally alternating with appendages; petals 0–6, crumpled, deciduous, inserted on the inner surface of the floral tube between the calyx lobes; stamens as many as or twice as many as the petals or numerous, inserted on the inner surface of the floral tube below the petals, anthers versatile; gynoecium often subtended at the base by a disc, stigma capitate or bilobed, style filiform, ovary superior, free in the floral tube, 2–4–locular; fruit a membranaceous capsule enclosed by the persistent floral tube, septicidally, septifragally, or loculicidally dehiscent, or indehiscent, splitting irregularly. Seeds 3 to many, the embryo straight, endosperm scant or none.

1. Floral tube campanulate to globose, about as long as wide.
   2. Plant woody, perennial, over 1 m tall; petals showy, 8–20 mm long.
      3. Flowers in axillary dichasia; petals 8–15 mm long; stamens 8–10; shrubs of shallow water . . . . . 1. *Decodon*
      3. Flowers in terminal panicles; petals 12–20 mm long; stamens numerous, more than 10; terrestrial trees or shrubs . 2. *Lagerstroemia*
   2. Plant herbaceous, annual or perennial, generally less than 50 cm tall; petals to 4 mm long or none.
      4. Appendages present in the sinuses of the calyx lobes, or if absent then the bracteoles nearly equal to the length of the floral tube; flowers 1 to many in the axils of leaves; petals 4 (rarely 0); capsule dehiscent.
         5. Middle and upper leaves attenuate at base; flowers solitary in the axils of leaves; capsule dehiscing septicidally, the outer wall of the capsule finely and densely transversely striate . . . . 3. *Rotala*
         5. Middle and upper leaves cordate to auriculate at base; flowers (1–)3 to many in the axils of leaves; capsule dehiscing irregularly, the outer wall of the capsule smooth, not striate . . 4. *Ammannia*
      4. Appendages absent in the sinuses of the calyx lobes; bracteoles minute on the pedicel; flowers solitary in the axils of leaves; petals 0; capsule indehiscent . . . . . 5. *Didiplis*

1. Floral tube cylindrical, elongate, about twice as long as wide.
   6. Flowers regular; floral tube entire in fruit; capsule dehiscing septicidally from the apex, the placenta included; seeds numerous, mostly more than 20 . . . . . 6. *Lythrum*
   6. Flowers irregular; floral tube and capsule splitting longitudinally along the upper side in fruit, the placenta then exserted; seeds 3–20.7. *Cuphea*

1. DECODON J. F. Gmelin

1. D. VERTICILLATUS (L.) Ell., Swamp Loosestrife—Perennial shrubs, glabrous to velutinous, spreading by arching stems rooting at tips and with submerged stems basally thickened by spongy aerenchyma. Leaves opposite or whorled, lanceolate, shortly petiolate, 3–20 cm long, 0.5–5 cm wide. Inflorescence of 1–3 shortly pedunculate axillary dichasia at a node. Floral tube campanulate, greenish; flowers trimorphic with styles and stamens of 3 lengths; calyx lobes 4 or 5(–7), alternating with and mostly ½ the length of narrowly triangular, thickened appendages; petals 4 or 5(–7), rose purple, 8–15 mm long, about twice the length of the floral tube; stamens 8–10, the filaments of 3 possible lengths, 2 of the 3 lengths occurring in any one flower; capsule globose, loculicidal, 3–5–locular. Seeds 20–30, small, inverted-pyramidal. (n=16) Summer. Swamps, edges of ponds and lakes in shallow water; all prov. SE /All/ A monotypic eastern North American genus distributed from southeastern Canada and Maine to Minnesota, south to Louisiana and Florida.

Glabrous specimens said to occur mostly inland (Gleason and Cronquist, 1963) have been called var. *laevigatus* T. & G. On the basis of admittedly limited herbarium material from beyond the southeastern states it appears that there are in fact relatively few entirely glabrous specimens and that, although these occur primarily inland, glabrous plants occur near coastal areas as well, e.g., Cameron Parish, La., Jones Co., N.C., Washington, D.C. Conversely, plants with the more common velutinous condition, although mostly coastal or in the Mississippi Valley, have also been collected inland, e.g., Noble Co., Ind. and Jefferson Co., N.Y. Distinctive geographical limits for the varieties based on degree of vestiture seem to be lacking, and in the absence of other discriminatory characters I prefer not to recognize varietal rank within the species.

2. LAGERSTROEMIA L.

1. L. INDICA L., Crape-Myrtle—Long-lived shrubs or small trees. Leaves ± alternate, obovate or oblong-elliptic, sessile or shortly petiolate, 15–60 mm long, 5–40 mm wide. Inflorescence of showy multi-flowered terminal panicles. Floral tube subglobose, 10 mm long, on pedicels 3–15 mm long; calyx lobes 5–7, erect, shorter than the floral tube, appendages lacking; petals 5–7, purple, rose, or white, long-clawed, 12–20 mm long; stamens numerous; capsule subglobose, loculicidal, (3–)6–locular. Seeds flattened, winged, 3 or 4 per locule. (n= 24, 25) Spring–Fall. Native to Asia, widely cultivated throughout the SE and possibly naturalized to a limited extent.

3. ROTALA L.

Annual glabrous herbs, often much branched, 0.5–4 dm tall. Leaves opposite or whorled, linear to spathulate, attenuate at the base, mostly sessile. Flowers solitary, axillary, sessile or subsessile, 4(–6)–merous; pedicels bi-

bracteolate. Floral tube campanulate to globose or urceolate, 2–5 mm long, calyx lobes 4(–6), appendages present or wanting between the lobes; petals 4(–6), white to pink; stamens 4(–6); capsule with microscopic dense transverse striations on the outer wall, septicidally dehiscent, 2–4–locular. Seeds many, minute, ovoid, plano-convex.

1. Leaves linear to oblanceolate; floral tube bearing appendages between the calyx lobes; bracteoles less than ½ the length of the floral tube. . . . . 1. *R. ramosior*

1. Leaves obovate to spathulate; floral tube lacking appendages; bracteoles ± equalling the length of the floral tube . . . . . 2. *R. indica*

1. R. RAMOSIOR (L.) Koehne, Tooth-Cup—Herb 0.5–4 dm tall. Leaves opposite or whorled, linear to oblanceolate, 10–50 mm long, 2–12 mm wide. Flowers axillary, sessile, bracteoles at the base of the floral tube less than ½ the length of the floral tube. Floral tube 2–5 mm long; calyx lobes alternating with triangular appendages of size nearly equal to the lobes; petals scarcely exceeding the calyx lobes, deciduous; capsule 2–4–locular. (n=16) Mid-summer-Fall. Muddy or sandy shores or damp depressions; all prov. SE /All/ Also from Mass S to Fla, E to E Tex, US west coast, Cent. Am, S. Am, Antilles.

The species bears a superficial resemblance to both *Ammannia coccinea* Rottb. and *Ludwigia palustris* (L.) Ell. (Onagraceae), with which it is sometimes confused. The obvious characters in *Rotala*—i.e., upper leaf bases tapering, solitary flowers in the axils, and minute transverse striations on the capsule—easily distinguish it from *Ammannia*, which has upper leaf bases auriculate, generally 3 or more flowers in axillary cymes, and a microscopically smooth capsule wall. Easily observed characters of *Ludwigia palustris* that distinguish it from *R. ramosior* are the absence of appendages between the lobes and the presence on the floral tube below each calyx lobe of a thickened green band through which the outline of seeds may be seen in the dry state.

More robust plants of *R. ramosior* occurring inland from the coastal plain have been recognized as var. *interior* Fern. & Griscom on the basis of but slightly greater size of leaves, bracteoles, and capsules.

2. R. INDICA (Willd.) Koehne—Herb 0.5–3 dm tall. Leaves opposite, obovate to spathulate, 4–17 mm long, 1–8 mm wide, the margins thickened, translucent, the apex minutely mucronate on young leaves. Flowers subsessile on foliaceous branchlets; bracteoles ± equalling floral tube in length, narrowly linear, acute. Floral tube 2–3 mm long; calyx lobes narrowly triangular, 1.5 mm long, lacking alternating appendages; petals much shorter than the calyx lobes, persistent; capsule 2-locular. Summer-Fall. Rice fields; Acadia Parish, La/Calif/ Native to S Asia.

A native of southern Asia, this species is thought to be an introduction through rice culture in California (Mason, 1957). It has recently also been found in rice fields in Louisiana (Thieret, 1972, and M. Piehl, 1974, pers.

comm.) According to Thieret (pers. comm., 1972) the species has persisted and spread in its second year in the area where it was first collected. For this reason and because it might be expected to appear in other rice growing areas of the southeast it has been included in this treatment.

4. AMMANNIA L.

Annual glabrous herbs, 1–11 dm tall, with ascending branches. Leaves opposite, narrow, linear to lanceolate or oblanceolate, sessile, auriculate or cordate, rarely tapering to the base. Flowers small, 4-merous, in sessile or pedunculate axillary cymes, (1–)3–10 flowers per cyme; pedicels bibracteolate. Floral tube campanulate to urceolate, 2–6 mm long, greenish to rose-colored, 4-angled at anthesis; calyx lobes 4, alternating with short, horn-shaped appendages; petals 4 or 0, small, purple to pink, early deciduous; stamens 4(–8); capsule globose, irregularly dehiscent, outer wall smooth, not striate. Seeds many, minute, ovoid.

1. Style in fruit exserted, filiform, equal to or longer than the ovary; calyx lobes triangular, the apices acute . . . . . 1. *A. coccinea*
1. Style in fruit included, much shorter than the ovary; calyx lobes obtuse, the apices often minutely mucronate . . . . . 2. *A. latifolia*

1. A. COCCINEA Rottb.—Leaves linear and attenuate to narrowly oblong, 2–11 cm long, 2–10 mm wide, the apex acute, the base auriculate-cordate. Inflorescence a closely-flowered, short-pedunculate cyme, flowers (1–)3–5(–10) per cyme, peduncles to 3 mm long. Petals 4; style filiform, equal to or longer than the ovary, exserted in fruiting calyx; calyx lobes triangular, the apex acute; capsule 3–5 mm in diameter, included to barely surpassing the calyx lobes. Summer-Fall. Wet places; all prov. SE (except Ala?) /Mo, Ill, Ind, Ohio, NJ/ Also sporadic to west coast and in Mex, Antilles, S. Am.

Two long-styled species of *Ammannia* have been cited from southeastern United States (Fernald, 1950), *A. coccinea*, characterized by closely (1–)3–5(–10)-flowered sessile or nearly sessile cymes and *A. auriculata* Willd., with smaller, more-numerous flowered (3–15 flowers) long-pedunculate cymes. *Ammannia coccinea* is frequently collected throughout eastern and central United States and ranges southward into South America via the Caribbean and Mexico. *Ammannia auriculata* is a species of world-wide distribution, occurring in Africa, Asia, Australia, Latin America and is infrequently collected in the United States from Texas north to South Dakota and possibly also in California, but to my knowledge is not present within the boundaries of the *Vascular Flora*.

Ammannia coccinea and *A. auriculata* are sympatric over a very wide area, i.e., the central United States, Mexico, the Caribbean, and northern South America. Throughout the area of sympatry, specimens representing apparent hybrids or introgressants have been collected. These resemble *A. coccinea* most closely, but they display the elongate peduncle of *A.*

auriculata and are most often identified as that species. The possible introgressants are also found infrequently outside the range of *A. auriculata* in the southeastern states bordering the Mississippi River. Other characters such as flower number and capsule size, although statistically significant in separating the two species, may or may not be sufficiently distinct on any one individual to be a useful distinguishing feature. A biosystematic study of these species is currently in progress.

Occasional specimens of *A. coccinea* from well outside the range of *A. auriculata* are found with the most mature cymes fully elongated into short branches, succeedingly younger cymes with slightly elongate to sessile peduncles (cf. *Godfrey 64910* from Florida, LAF, TEX, UNC; and *Thorne 5628* from Georgia, GH). In this case it would appear that elongate peduncles must be attributed to a genetic change not connected with hybridization.

2. A. LATIFOLIA L.—Leaves lanceolate to narrowly elliptic or spathulate, 5–14 cm long, mostly about 8 mm wide, the apex obtuse to subacute, the base of middle and upper leaves auriculate, the lowest cuneate. Inflorescence a closely flowered, short-pedunculate cyme, flowers 3–10 per cyme, peduncles to 3 mm long. Petals 4 or 0; style much shorter than the ovary, included in fruiting calyx; calyx lobes broad, rounding, the apex often minutely mucronate; capsule 4–6 mm in diameter, included. Summer-Fall. Brackish waters; cp. Md, Va, NC, GA, Fla, Miss, La/NJ, Tex/ Also Mex, S. Am., Antilles. *A. teres* Raf.—F, G, R; *A. koehnei* Britt.—S.

Two short-styled species of *Ammannia* are commonly recognized from the Atlantic and Gulf coasts, *A. teres*, distributed from New Jersey to Florida and westward to Texas, and *A. latifolia*, primarily a Caribbean species reaching northward into southern peninsular Florida. The major difference between the two taxa is the purported presence of petals in *A. teres* and their absence in *A. latifolia*. Leaf shape and size and capsule size have also been used to separate the species.

In the course of a revisionary study of the genus I have tabulated these characters for United States, Caribbean, and Latin American specimens. No geographically-limited character was found by which more than one species or even variety could be defined. Although petals occur on all plants examined from New Jersey to northern Florida, they also occur sporadically throughout the Caribbean on 30% of the specimens examined. At least four other species of *Ammannia* have petals that vary from 0–4, so that variability of this character within a species is not unusual for the genus.

Leaf size is not significantly different between the two species even at the northern and southern range extremes. The upper leaf shape is primarily lanceolate to spathulate in the north, becoming more commonly linear-lanceolate from North Carolina southward, with spathulate-leaved specimens occurring infrequently in the Caribbean. Capsule size is more variable in the north, but the difference in mean size at the geographic extremes is less than 0.5 mm.

Because of the lack of stable morphological characters which can be geographically characterized, only one short-styled species of *Ammannia*, *A. latifolia*, is recognized in eastern United States. Although this species is variable, it is without definable infraspecific groups. *Ammannia teres* is relegated to synonymy. The complete synonymy and more extensive data supporting these changes will be presented in a revision of *Ammannia* in the Western Hemisphere (Graham, unpub.)

Fernald's *A. teres* var. *exauriculata* is merely a form in which the basal auriculate lobes on some of the upper leaves are much reduced. This apparently sporadic character is known also from collections from the Bahamas (*Small & Carter 8965*, US) and from Yucatan (*Lundell & Lundell 8188*, MEXU).

5. DIDIPLIS Raf.

1. D. DIANDRA (DC) Wood, Water-Purslane—Delicate annual aquatic herbs, 1–4 dm long. Leaves thin, opposite, 5–30 mm long, 0.5–4 mm wide, narrowly linear or elliptic, the submersed leaves linear, truncate at the base, the emersed leaves narrowly elliptic, shorter with tapering base. Flowers minute, greenish, 4-merous, solitary, axillary; calyx lobes 4, broadly triangular, intersepalar appendages lacking; petals none; stamens 2–4, included; style short or wanting; capsule globose, indehiscent, irregularly splitting, 2-locular. Seeds many, small, spathulate, the distal end enlarged and curved. Late Spring-Summer. Margins or shallow waters of lakes, ponds, temporal pools; all prov? SE /All?/ Reported from Tex to Fla, north to Minn and Va, but SE herbaria contain specimens only from Ky, La, Miss, NC, and Va. A monotypic genus endemic to eastern North America. *Peplis diandra* Nutt. ex DC.—F, R.

The decision to recognize *Didiplis* as a monotypic genus endemic to North America versus placing it in *Peplis* (cf. Graham, 1964) is based on Webb's (1967) convincing arguments for the merging of the European species of *Peplis* with *Lythrum*. According to Webb, morphological similarities or actual overlap in characters of habit, petal and stamen number, shape of the floral tube, and type of capsule dehiscence, especially as evidenced in the little-known European *Lythrum thesioides* Bieb. and *L. borysthenicum* (Schrank) Litv. (*Peplis erecta* Req. ex Moris) erase the distinctions between the two genera. One apparent exception is *Didiplis diandra*, a species with 4-merous, rather than 6-merous flowers which lack the appendages (epicalyx) found on all other species of *Lythrum* and *Peplis*. The flowers of *Didiplis*, often produced on totally submerged plants, are solitary, minute, and greenish, with both appendages and petals lacking, probably reduced in response to the aquatic environment.

In *Lythrum* the 4-merous floral condition is present in a few species, such as *L. thymifolia* L. and *L. tribracteatum* Salzm. ex Sprengel and appendages may be conspicuously reduced ("*subnullae*" fide Koehne, 1903, p. 59) or inconspicuous, to 0.5 mm long or less, as in *L. tribracteatum* (Webb, 1968,

p. 302). The presence of such character states in *Lythrum* suggests that *Didiplis* is no more easily separated from *Lythrum* than is *Peplis*. Without studying the European species involved and lacking sufficient study material of *Didiplis* itself, I choose to follow Webb's suggestion for the present, that *Didiplis* be treated as a monotypic American genus.

Didiplis diandra is a delicate aquatic herb of shallow, often ephemeral waters. Though most floras record its range as covering much of eastern United States, there are only 12 herbarium specimens present in the southeastern herbaria whose collections I studied. It is probably overlooked by collectors because of its inconspicuous habit and flowers. In view of its questionable taxonomic status, it is hoped botanists will be aware of the need for more extensive flowering and fruiting collections, from both submersed and emersed populations.

6. LYTHRUM L.

Perennial, rarely annual, herbs or small shrubs, stems often prominently 4-angled, 1–12 dm tall. Leaves glabrous or rarely pubescent, opposite, alternate, or whorled, ovate to linear, sessile or shortly petiolate, reduced in the inflorescence. Flowers regular or nearly so, homomorphic or heteromorphic with styles and stamens of 2 or 3 lengths, 6-merous, axillary, 1 or 2 at a node or in terminal spikes; pedicels bibracteolate. Floral tube cylindrical, greenish, 8–12-nerved, 4–8 mm long; calyx lobes alternating with appendages; petals 6, rose-purple, purple, pink, or white, deciduous; stamens 6 or 12; ovary 2-locular, with or without a thickened ring at the base; capsule septicidal or septifragal. Seeds many, small, ovoid.

1. Flowers solitary or paired in the axils; stamens usually 6.
   2. Leaves mostly opposite along the entire stem, mostly shorter than the internode above.
      3. Leaves oblong, base obtuse; stems short, 1–4 dm tall, several from a creeping rhizome . . . . . 1. *L. flagellare*
      3. Leaves linear to narrowly lanceolate, base attenuate; stems tall, 3–15 dm, slender, wand-like . . . . . 2. *L. lineare*
   2. Leaves mostly alternate, generally only the lowermost opposite, the middle and upper ones alternate, mostly longer than the internode above.
      4. Branch leaves distinctly, abruptly reduced in size from stem leaves, openly spaced on branches; appendages and calyx lobes equal in length . . . . . 3. *L. curtissii*
      4. Branch leaves gradually reduced in size from stem leaves, crowded and overlapping in inflorescence; appendages 2x the length of the calyx lobes . . . . . 4. *L. alatum*
1. Flowers numerous in showy terminal spikes; stamens usually 12. . . . . 5. *L. salicaria*

In the most recent treatment of *Lythrum* in the United States (Shinners, 1953) at least seven, possibly eight, species are reported to occur in southeastern United States. My studies of the genus, including examination of type material not seen by Shinners, suggest that there are five species of *Lythrum*, one comprising two varieties, in the area covered by the proposed *Vascular Flora*.

1. L. FLAGELLARE Shuttl. ex Chapm.—Slender, herbaceous perennial with several erect to decumbent stems arising from a woody creeping rhizome, 1–4 dm tall; stems nearly terete, sparsely branched. Leaves strictly opposite, sessile or subsessile, oblong to obovate, 5–13 mm long, 2–6 mm wide, scarcely or not at all reduced in the inflorescence, the apex and base rounded. Flowers solitary, dimorphic; pedicels 0–1.5 mm long. Floral tube 4–5 mm long, gradually widening toward the distal end; appendages about 2× the length of the calyx lobes; petals pale purple to purple, 3–4 mm long; hypogynous ring 0.5 mm tall and 0.5 mm wide. Spring. Wet places; cp. Fla. Infrequently collected endemic, known from Collier, Hendry, Lee, Manatee, Okeechobee, Orange, and Sarasota counties.

This rare Florida endemic is distinguished by short stems from a creeping rhizome and small, oblong, strictly opposite leaves which are scarcely reduced in the inflorescence. The species is very closely allied to the widespread Mexican *L. acinifolium* (DC) Koehne, differing in growth habit and size of stems and lower leaves. Both species are perennial from a creeping rhizome. Stems of *L. acinifolium* tend to be woody and erect with at least some stems up to 7 dm tall. Stems of *L. flagellare* are less woody, up to 4 dm tall and often decumbent. Lowermost leaves of *L. acinifolium* tend to be somewhat larger than in *L. flagellare*. The species cannot be separated by floral morphology. A definitive statement of their relationship awaits an understanding of the range of variability in the Mexican species.

2. L. LINEARE L.—Perennial with basal offshoots, the stems slender, wandlike, the upper portion of the plant much branched, 3–15 dm tall. Leaves of stems and inflorescence mostly opposite, narrowly linear to lanceolate, sessile, 5–40 mm long, 1–4 mm wide, mostly shorter than the internode above, slightly fleshy. Flowers paired in the axils, oriented nearly parallel to the stem, dimorphic; pedicels 0.5–1.5 mm long. Floral tube 3–5 mm long; calyx lobes and appendages subequal in length; petals pale purple or white, 3–4 mm long; basal stipe of ovary scarcely or not at all thickened into hypogynous ring, abaxial and adaxial sides of the stipe 0.5 mm tall. ($n=10$) Summer. Brackish marshes; cp. SE.

The species is tall, slender, with narrow, linear, opposite leaves which are mostly shorter than the internode above. The petals are pale purple to white and often shorter than the floral tube. The ring at the base of the ovary is not at all thickened, as it is in all other native species of *Lythrum* in the Southeast. *Lythrum lineare* has a more open, less coarse aspect than does *L. alatum* var. *lanceolatum* (Ell.) Rothrock, a species with which it

may grow and is occasionally confused. The species is very strictly distributed in brackish waters of the coastal plain from Delaware in the north (possibly north to Long Island, fide Fernald, 1950, though I have seen no specimens from there), south to southernmost Florida and west into Louisiana. It is not known from Texas, as reported by Fernald (1950), collections so labeled representing either *L. alatum* var. *lanceolatum* or *L. californicum* S. Wats. A possible hybrid with *L. curtissii* (see the following species) has been collected in Georgia.

3. L. CURTISSII Fernald—Slender, much branched perennial, 5–10 dm tall, stems 4-angled; branches numerous, short, ascending, flexuous, highly floriferous. Leaves thin, yellow-green, oblong to elliptic, the apex obtuse or acute, the base tapering, the lower leaves mostly opposite, the middle and upper ones mostly alternate, sessile or subsessile; stem leaves 20–75 mm long, 5–15 mm wide; branch leaves distinctly and abruptly much reduced, 3–15 mm long. Flowers mostly solitary, often oriented at a 45-90° angle with the stem, dimorphic; pedicels slender, 0.5–1.5 mm long; bracteoles present at the top of the pedicel. Floral tube 3–6 mm long, the distal end and nerves often purple-tinged; calyx lobes and appendages ± equal in length; petals deep to pale purple with darker central vein, 2 mm long; hypogynous ring 0.5 mm tall. (n=10) Summer. Wet places, rare; cp. Fla, Ga. Endemic known from Calhoun and Miller Co., Ga. and Gadsen, Liberty, and Franklin counties, Fla.

A species with slender, flexuous, pyramidal ascending branches and many small delicate flowers, it is a rare endemic of southwestern Georgia and adjacent counties in Florida. Besides its unique habit, it is distinguished by having main stem leaves distinctly larger than the branch leaves and purple petals generally only 2 mm long. A specimen suggestive of both *L. curtissii* and *L. lineare* has been collected at or near the type locality of *L. curtissii* (*Kral 28630*, VDB). It is a plant with linear leaves, alternate on the upper stem and gradually decreasing in size toward the summit, leading it to be keyed with difficulty to *L. lineare*. The flowers tend to be held more erect than is typical of *L. curtissii* and are at the large end of the size range for that species with petals 4–5 mm long as opposed to 2 mm in typical *L. curtissii*. However, the petals are of the deep purple hue characteristic of *L. curtissii* rather than pale as in *L. lineare*, the appendages are longer than found in either species, and a hypogynous ring, normal in *L. curtissii* but lacking in *L. lineare*, is present. *Lythrum lineare* is not known to occur as far inland as Calhoun Co., Ga. Both species are known from Franklin Co., Fla., but no evidence of hybridization has been noted in collections from that county.

4. L. ALATUM Pursh—Perennial herb with basal offshoots, the stems slender to robust, up to 1 m tall, virgate, the upper part of the plant much branched. Leaves dark green above, green to gray-green beneath, sessile, ovate to oblong with rounded to subcordate base or lanceolate with tapering base, the lower stem leaves opposite to mostly subopposite, 10–76 mm long,

2–14 mm wide, the middle and upper leaves subopposite to mostly alternate, reduced in size, crowded and overlapping on the branches. Flowers solitary, axillary, held nearly erect, bibracteolate on pedicels 1–3 mm long, dimorphic, with either style or stamens exserted. Floral tube 3–7 mm long, green; appendages ca. 2× the length of the calyx lobes; petals purple, 2–6.5 mm long; thickened hypogynous ring present at the base of the ovary, narrowed on the ventral (abaxial) side. ($n=10$)[2] Summer. Wet soils, ditches, thickets; all prov. SE /All/ Common throughout eastern and central US. The more robust southern plants with lanceolate leaves and tapering leaf bases are referred to var. *lanceolatum* (Ell.) T. & G. ex Rothrock. *L. lanceolatum* Ell.—F, R, S.

Most widespread of the United States species of *Lythrum*, *L. alatum* has been divided by various authors into as many as four species. Shinners (1953) recognized as present in the Southeast *L. alatum*, *L. lanceolatum*, *L. dacotanum* Nieuwl., and provisionally *L. cordifolium* Nieuwl. He considered *L. alatum* and possibly *L. cordifolium* as rare southeastern endemics and felt that the epithet *alatum* had been incorrectly applied to the common midwestern plants that he referred to *L. dacotanum*. Floras treating southeastern United States or adjacent areas have recognized *L. alatum* and *L. lanceolatum* as distinct species (Fernald, 1950; Small, 1933; Radford, Ahles, and Bell, 1964), as varieties of a single species (Torrey & Gray, 1840; Gleason & Cronquist, 1963; Long and Lakela, 1971), or have followed Shinners' taxonomic and nomenclatural interpretations (Blackwell, 1970; Correll and Correll, 1972). The taxa have been distinguished primarily on the basis of leaf shape, secondarily by quantitative (though overlapping) differences in leaf size and floral tube and petal length, and by position of the bracteoles on the pedicel.

Lythrum is considered a notoriously difficult genus due to the vegetative variability within a species and the superficial similarities among the species. In addition, introgression appears to occur in areas of sympatry, further blurring species distinctions. Analysis of the variability in this widespread complex centering around *L. alatum* was conducted as a basis for defining the number of species or infraspecific taxa present in the Southeast. Approximately 200 specimens were selected from collections spanning the entire range of all species involved and were scored for leaf shape (by tracings of the longest leaf), and for leaf length and width, floral tube and petal length, and bracteole position. Type material of *L. alatum*, *L. dacotanum*, *L. cordifolium*, and *L. lanceolatum* (using a photograph of the type) was included in the study.

To more easily observe any clinal changes that might be present, I divided the specimens into ten geographical areas. On the basis of the most conspicuous and easily determined character, leaf base shape, the areal bound-

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[2] A published count of $n=5$ (Smith, E. B., 1963 in Madroño 17:117) has been corrected to $n=10$ based on material from the same locality (R. Ornduff, pers. comm., 1974).

aries were drawn to include all plants with round to subcordate-based leaves (*L. alatum* of most authors) in areas 1–5 and plants with tapering leaf bases (*L. lanceolatum* of several authors) in areas 6–10. These two major categories were also compared with each other (Fig. 1; Tables 1 and 2).

Although *L. alatum* is dimorphic in stamen and style length, no other gross morphological differences were correlated with this condition. Long-styled and short-styled plants both showed the same variability in the features measured and so were not considered separately in the survey.

Fig. 1. Variability in leaf shape throughout the range of *Lythrum alatum*. Outline tracing of actual longest leaf on each plant examined with groups 1-10 selected to represent total diversity in shape for each area. Leaf tracings from type material of *L. alatum*, *L. cordifolium*, *L. lanceolatum*, and *L. dacotanum* are indicated by the letters A, C, L, and D, respectively. Geographical limits of areas 1-10 are listed in Table 1.

Table 1. Variability in selected characters of *Lythrum alatum*, arranged according to the following geographic areas. 1. Maine-W. Va, 2. Ohio, Mich, Ind, Ill, Wis, 3. Minn, N & S Dak, N. Okla, 4. Ia, Mo, N. Ark, 5. Ky, Tenn, N. Ala, N. Ga, 6. Va-S. Ga, 7. Fla, 8. S. Ala-Miss, 9. La-S. Ark, 10. Tex-S. Okla. n=number of plants scored.

Character	Area	n	min–max	mean	standard deviation
Leaf length/width	1	3	3.7 – 4.7	4.4	0.58
	2	6	3.6 – 7.0	5.2	1.5
	3	10	2.1 – 7.3	3.9	1.4
	4	6	2.8 – 6.7	4.2	1.3
	5	7	2.6 – 5.3	4.0	1.1
Totals	1–5	32	2.1 – 7.3	4.3	1.3
	6	8	2.5 – 8.4	5.9	2.2
	7	7	4.5 – 8.5	5.7	1.3
	8	6	4.2 – 8.8	6.3	1.9
	9	8	2.8 – 12.5	6.5	3.2
	10	5	3.6 – 9.0	5.3	2.2
Totals	6–10	34	2.5 – 12.5	6.0	2.2
Longest floral tube length, mm	1	6	5.0 – 6.0	5.3	0.42
	2	19	4.0 – 6.0	5.4	0.58
	3	19	5.0 – 7.0	5.5	0.56
	4	12	4.0 – 6.0	5.0	0.55
	5	17	4.5 – 6.0	5.1	0.39
Totals	1–5	73	4.0 – 7.0	5.3	0.51
	6	20	4.0 – 6.0	4.7	0.62
	7	22	4.0 – 6.0	4.8	0.57
	8	21	3.0 – 7.0	5.2	1.10
	9	20	4.0 – 6.0	4.7	0.62
	10	7	4.0 – 6.0	5.0	0.76
Totals	6–10	88	3.0 – 7.0	5.0	0.72
Longest petal length, mm	1	4	4.0 – 6.0	5.3	1.0
	2	19	4.0 – 6.5	4.8	0.82
	3	19	3.0 – 6.0	4.8	0.76
	4	12	3.0 – 6.0	4.6	0.88
	5	14	3.0 – 5.0	3.9	0.73
Totals	1–5	68	3.0 – 6.5	4.6	0.87
	6	18	2.0 – 5.0	3.9	0.92
	7	19	2.0 – 5.0	3.9	0.72
	8	18	2.0 – 5.5	4.1	0.92
	9	15	3.0 – 5.5	4.2	0.56
	10	5	4.0 – 5.0	4.4	0.54
Totals	6–10	75	2.0 – 5.5	4.0	0.79

Table 2. Bracteole position on pedicels of *Lythrum alatum*, arranged according to geographical areas listed in Table 1.

Area	No. of Plants with Bracteole Position at Base	Mid	Upper
1	7	3	4
2	15	0	3
3	9	2	8
4	9	0	3
5	7	3	4
	47	8	22 = 77
% of total	61%	10%	29%
6	4	2	17
7	3	1	17
8	7	3	28
9	6	9	28
10	1	1	5
	21	16	95 = 132
% of total	16%	12%	72%

The most obvious differences among the specimens lie in the leaves. After the leaf shape of the longest leaf of each specimen was traced the leaf tracings (Fig. 1) were selected to provide a picture of the leaf variability within each area and a tracing representative of the extremes and middle of the geographic range for each area. Shinners' distinctions, based on leaf length/width ratios between *L. lanceolatum* and *L. dacotanum* (4–15× as long as wide) and his *L. alatum* (1½–3½× as long as wide) are not maintained, these ratios also being found throughout most of the range of *L. alatum* (Fig. 1). Ovate to oblong leaves with rounded bases are typical of northern and midwestern plants while plants of the south have lanceolate leaves with tapering bases. No clinal differences can be recognized in this character since round-based ovate leaves broadest at the base become lanceolate in shape when there is a change to tapering base, the broadest width being transferred upward toward the middle of the leaf. There is considerable overlap in leaf length/width ratios of the two major areas, north and south (Table 1). The lanceolate leaves tend to be longer and narrower than ovate leaves but more variable, and there is no gradual shift to longer, narrower leaves from north to south.

For floral tube and petal length the maximum size on each specimen was recorded (Table 1). Floral tubes and petals of the northern and central plants tend to be slightly larger than those in the south, but the differences are scarcely significant taxonomically. Again, there is no clinal change in size of either character.

Lythrum alatum is said to have bracteoles at the base of the pedicel and

L. lanceolatum to have bracteoles on the upper half of the pedicel. In the northern areas (1–5) 61% of the plants examined had bracteoles positioned at the base of the pedicel (Table 2). In southern areas (6–10) the position is reversed with 72% of the plants scored having bracteoles on the upper part of the pedicel just below the floral tube. Although there is a significant difference in this character between plants of the north and south, its practical value in identification of individual specimens is limited by its variability. Again, there is no obvious shift in bracteole position in a clinal manner from north to south.

For the five characters examined only leaf shape provides a definitive taxonomic character. The other four characters are too similar to be utilized in identification and are certainly too similar to provide a basis for recognition of more than one species.

Greenhouse-grown plants provided two additional taxonomic features not always evident on herbarium specimens. Plants representing populations of *L. alatum* from six states grown under uniform conditions showed marked differences in stature and production of winter shoots. The southern plants i.e., those from Mississippi, Arkansas, and Texas, were taller with sturdier, more substantial stems than those from Kansas, Michigan, and Ohio. Herbarium specimens of the southern plants most often have a single main stem while specimens from the northern and central states most often have several slender stems closely arising from an enlarged rootstock. Stature correlates with shape of the leaf base. The robust, tall plants all have tapering leaf bases, and the shorter, slender-stemmed plants have rounded to cordate-based leaves.

A second feature, the production of prostrate, dark green, somewhat fleshy winter shoots, does not appear to be correlated with leaf base type. The shoots develop from the rootstock or from buds on the lower portions of older stems as the aerial stems die or become dormant. In the greenhouse, winter shoots are maintained into the spring when buds on the erect dormant stems begin growth. The shoots apparently do not become erect or persist into the summer but may give rise to new erect stems by rooting nodally and internodally where they contact the soil. Greenhouse grown plants from Kansas (with cordate-based leaves), Texas, Arkansas, and Mississippi (all with lanceolate leaves) display winter shoots; those from Michigan and Ohio do not. Production of winter shoots may be a genetically-based response to moderate climatic conditions.

The evidence presented in this study supports recognition of only one species in the *L. alatum* complex in the Southeast, with two varieties defined primarily by stature, leaf shape, and geographical range. The following nomenclatural notes, partial synonymies, and distribution map for *L. alatum* are based on specimens from the herbaria listed in the acknowledgments. They are not meant to be complete with respect to the species as it occurs beyond the range of the southeastern flora, as in the Caribbean region. The

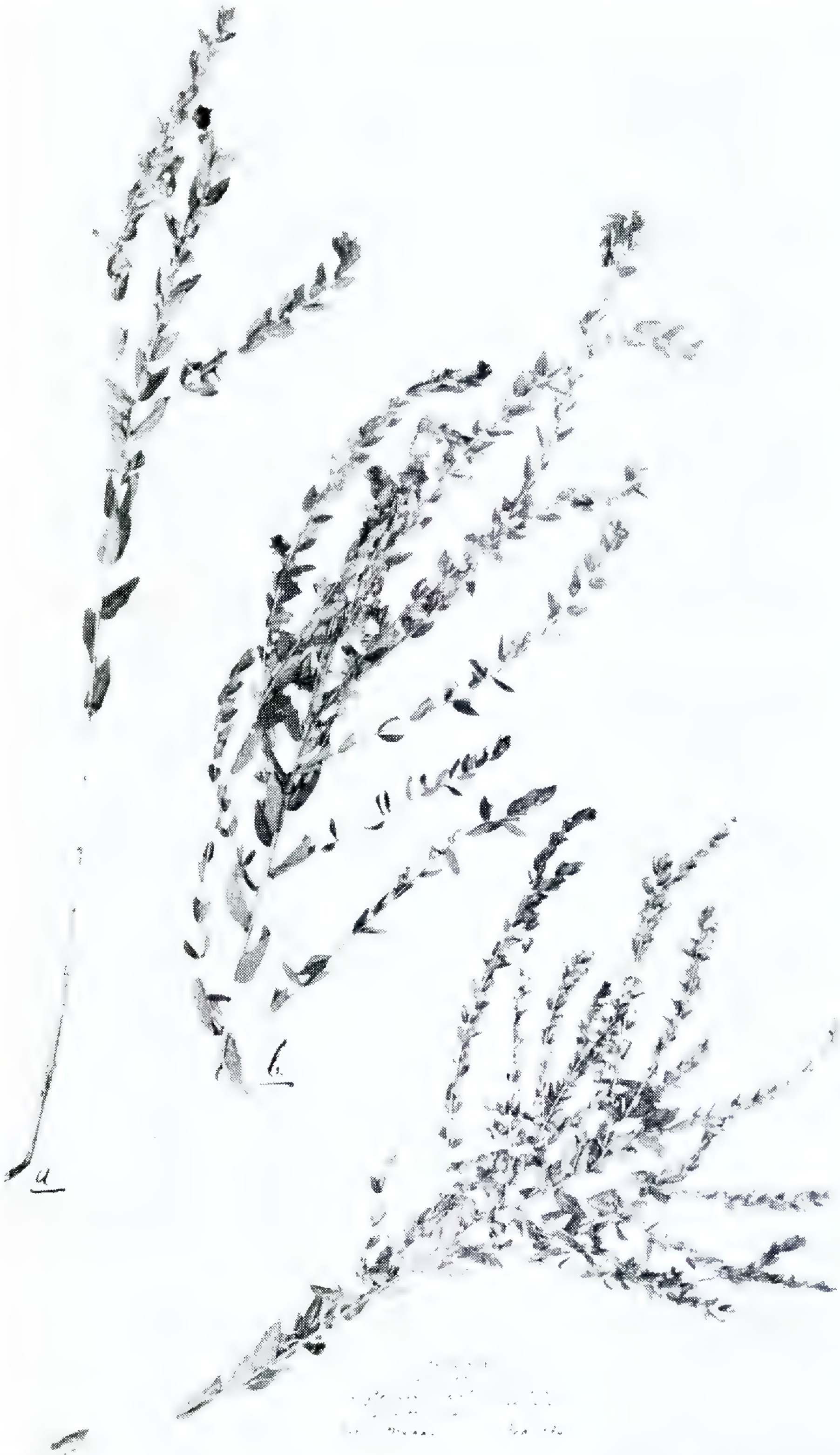
few synonyms not included represent later names and hence their absence is of no nomenclatural consequence with respect to this primarily floristic study.

Lythrum alatum Pursh, Fl. Am. Sept. 1: 334. 1814. Type: "In Lower Georgia. Enslen. June. July. v.s. in Herb. Enslen." (W!; possible isotype, W!) Fig. 2, a & b. The holotype of *L. alatum* Pursh at Vienna bears the epithet in the author's own hand, as attested to on the holotype by Prof. Joseph Ewan, who has made a thorough study of the work of Frederick Pursh (Ewan, 1952). The holotype and possible isotype are typical of the northern and midwestern plants of this species with ovate, round, or cordate-based leaves. The leaves of the holotype, described by Pursh as subcordate and opposite, are primarily alternate, though the lowermost leaves, which are often opposite in *Lythrum*, are lacking on the type. In size and shape the leaves fall within the variability displayed by the complex (see Fig. 1, area 5). The flower length of 5 mm also lies within the range of the complex. On the basis of morphology there is no doubt that the epithet *alatum* was correctly applied by Torrey & Gray and later authors and should not be reserved for an unknown rare endemic of coastal or southern Georgia as has been suggested (Shinners, 1953).

The exact geographical location of the type locality, recorded by Pursh as "Lower Georgia," is unknown. According to Ewan (1955) "we can learn little from the specimens as to Enslen's route in the South for there are no localities on the form labels." Any part of the state that could be considered "Lower Georgia," interpreted by Shinners as coastal or southern Georgia, lies outside the present range of the cordate-leaved *L. alatum*. That the plant could actually have come from the northwestern corner of Georgia, within its present-day boundaries, is very remote. Early maps of Georgia (Lewis, 1805; Low, 1810) show only two major trails through only a part of the area, that part of Georgia being firmly in control of the Cherokees until the 1830s (L. DeVorsey, Univ. Ga., Dept. of History, pers. comm., 1974). Ewan (pers. comm., 1974) suggests the possibility that the specimen was collected by John Lyon in the vicinity of Augusta, Georgia, in June 1803 and subsequently shared with Aloysius Enslen. Pursh apparently saw Enslen's collections in Philadelphia (Fl. Am. Sept., p. 12). The Enslen herbarium subsequently was acquired by the Vienna Botanical Museum in 1822.

Two other collections of cordate-leaved *L. alatum* are known from outside the apparent present range. One is an 1898 collection of A. S. Hitchcock from Citrus Co., Fla (MO, Fig. 3). The other is the type collection of *L. cordifolium* Nieuwl., S.B. Buckley s.n., no date, "N.C. to Ga. & Fla." (holotype, US!) or more specifically "Florida" (isotypes, NY, GH!) Both the Hitchcock and Buckley collections have unusually small leaves for *L. alatum*, but the flowers are identical to those of *L. alatum*. The basal parts and lower leaves are lacking on all the specimens. Difference in leaf size alone is not a sufficient basis for considering *L. cordifolium* as a species apart from *L. alatum* in view of the variability of this character in the species

Fig. 2. a. Photograph of type of *Lythrum alatum* Pursh (W), b. Closeup of flowering branch of the type.



a.

Typus

and in the genus as a whole. *Lythrum cordifolium* is regarded here as synonymous with the typical variety of *L. alatum*. The disjunct occurrence of these cordate-leaved specimens in Georgia and Florida would seem to indicate either that the range of this variety was once more extensive than it is at the present time, or that plants of this type occasionally are introduced into areas beyond the principal range. That the Hitchcock and Buckley specimens occur at the extremity of the species range may account for their unusually small leaves. It is of interest to note here that the range of a species very closely related to *L. alatum*, *L. californicum* S. Wats., has been severely restricted in northern California in recent years by man's activities and is now rare except for a few areas in southern California (Ornduff, pers. comm., 1974). Possibly *L. alatum* var. *alatum* has been eliminated from the southeastern coastal plain for the same reasons.

Lythrum dacotanum is also relegated to synonymy, the type represented by a robust, cordate-leaved specimen scarcely differing from the type of *L. alatum* except in its larger leaf size.

4a. LYTHRUM ALATUM Pursh var. ALATUM. *L. cordifolium* Nieuwl., Am. Midl. Nat. 3: 265-266. 1914. Type: N.C. to Ga. & Fla., S. B. Buckley s.n. (US no. 48371!; isotypes, GH!, NY), non *L. cordifolium* Sessé & Moc., 1888. *L. dacotanum* Nieuwl., Am. Midl. Nat. 3: 266-267. 1914. Type: Sioux Falls, S.Dak., Aug 1892, J. J. Thornber s.n. (US no. 240979!; isotype, US no. 516395!) The nominal variety is distinguished from var. *lanceolatum* by its generally slender stems up to 8 dm tall and ovate to oblong leaves with subcordate to rounded leaf bases. ($n=10$) All prov. Ark, Ala, Ga, Miss, Tenn, Ky, WVa, Va.[3] /All, except Tex/

Lythrum alatum var. *alatum* is incorrectly recorded as occurring in Louisiana and Texas (Fernald, 1950) and north-central Texas and the Texas panhandle (Correll and Johnston, 1970). These plants are, for the most part, *L. californicum*, which also has rounded leaf bases but linear-lanceolate, slightly fleshy, glaucous leaves, or *L. alatum* var. *lanceolatum*, or possibly hybrids or introgressants of the two. Probable hybrids of *L. alatum* var. *alatum* and *L. californicum* have been collected in northern Oklahoma and southwestern Kansas. *Lythrum californicum* and *L. alatum* are obviously closely related as indicated by the similar morphology and apparent ability to interbreed. A study of *L. californicum* in western United States and Mexico is needed to determine if its specific rank is justified or if it should be included within the *L. alatum* complex.

4b. LYTHRUM ALATUM var. LANCEOLATUM (Ell.) T. & G. ex Rothrock in G. M. Wheeler, Rept, U.S. Geographical Surveys West of the 100th Meridian, VI-Botany: 120. 1879. *L. lanceolatum* Ell., Sketch. 1: 544-545. 1821.

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[3] An additional southern locality for *L. alatum* var. *alatum* has come to my attention, but I have not seen the specimen. S.B. Jones in Lythraceae for the Mississippi Flora Project (unpublished) cites a single specimen from Desoto Co., which is the northwesternmost county in the state and lies along the southern line of distribution of the variety.

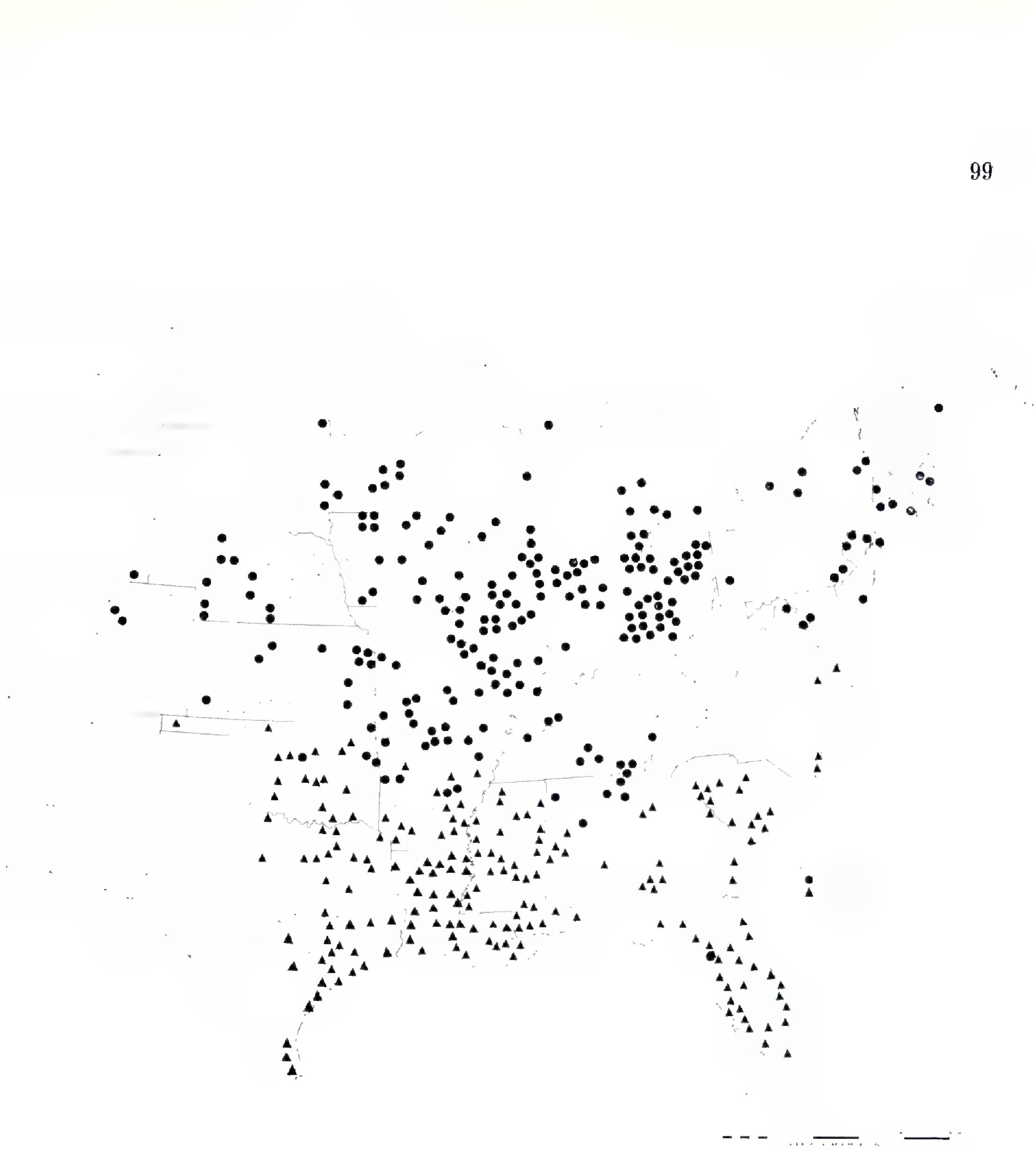

Fig. 3. Verified geographical distribution in the United States of *Lythrum alatum* var. *alatum* with round to cordate leaf bases and var. *lanceolatum* with tapering leaf bases.

Type: "Hab. in humidis. Flor. Jun. Jul." (US photo of type at CHARL!) The variety differs from var. *alatum* by its robust stems up to 1 m tall and the lanceolate leaves with tapering bases. ($n=10$) cp. SE except Md, Del, WVa, Ky, Tenn /Tex, Ok/ Also Antilles.

This varietal combination has been attributed to Torrey and Gray but appears never to have been validly published by them. According to Art. 33 of the *International Code of Botanical Nomenclature* (1972) the author must definitely indicate the epithet to be used in that particular combination. Torrey and Gray did not indicate any name be used in combination with *L. alatum*, but rather described two intraspecific categories, *alpha* and *beta*, and cited after the descriptions the species on which the descriptions were

based. Although *beta* is based on *L. lanceolatum* Ell. the combination is not made specifically. The first citation of the combination is by Gray, Pl. Lind. 6: 188. 1850, but the varietal name is enclosed by parentheses suggesting Gray did not accept the combination. The first validly published combination then was not made until 1879 by J. T. Rothrock.

The variety hybridizes freely with *L. californicum* outside the range of the southeastern flora in central Texas and Oklahoma and possibly also with *L. lineare*. Shinners (1953) observed specimens from Florida that suggested to him the influence of hybridization of the variety with *L. lineare*. Although their ranges are sympatric along the Atlantic and Gulf Coastal Plains from Virginia to Louisiana I have seen no specimens difficult to place. Hybridization between the two taxa, if it occurs, is probably infrequent. In general the taxa occupy slightly different habitats, *L. lineare* thriving in very wet soils and in brackish waters and hence restricted to the coastal plain, while *L. alatum* var. *lanceolatum* tolerates more variable habitats with regard to water supply and may be found well inland in habitats where water is only seasonally plentiful.

5. L. SALICARIA L.—Erect perennial, glabrous to often pubescent, to 12 dm tall. Leaves opposite or whorled, lanceolate, sessile, mostly longer than the internode above, 2–10 cm long, 0.5–1.5 cm wide, the base obtuse to cordate. Flowers in showy terminal bracteate spike-like inflorescences, trimorphic with styles and stamens of 3 lengths. Floral tube 4–6 mm long; appendages 2–3× longer than the calyx lobes; petals 6, rose purple, 7–9 mm long; stamens mostly 12; hypogynous ring absent. (n=15, 25, 30) Summer. Marshes, lake and river margins. Rare, WVa, Va, Watauga Co., NC. /Throughout the NE/ Naturalized from Europe.

This attractive early introduction from Europe is common throughout the Northeast but rarely reaches into southeastern United States. The species differs from all other *Lythrum* in the Southeast in having showy, rose-purple petaled flowers whorled in terminal spikes. There is no published record of the chromosome number $n=20$ cited in Radford *et al.* (1964) and it is presumed to be a typographical error.

7. CUPHEA P.Br.

Annuals or short-lived perennials, 1–6 dm tall with viscid, glandular hairs on stems and flowers. Leaves opposite or whorled, ovate to lanceolate, elliptic or linear, sessile or petiolate. Flowers irregular, 6-merous, 1–3 at a node, often interaxillary, in leafy racemes, the pedicels bibracteolate. Floral tube cylindrical, green or purple and green, distinctly 12-nerved, the base gibbous or spurred; calyx lobes 6, alternating with 6 short appendages; petals 6(–3), pale to deep purple, deciduous; stamens 11, alternately unequal, the 2 upper (adaxial) ones inserted deeper in the calyx tube than the others; ovary subtended at the base by a curved disc; capsule splitting longitudinally the length of the adaxial wall, the upper side of the persistent floral tube also

splitting, the placenta projecting out of the capsule and floral tube; seeds 3–20, dorsi-ventrally flattened. (*Parsonsia* P.Br., S.)

1. Leaves whorled; flowers opposite or whorled on pedicels 5–15 mm long. . . . . 1. *C. aspera*
1. Leaves opposite; flowers alternate on pedicels 0–5 mm long.
   2. Floral tube green, 4.5–6 mm long, glabrous within; stamens much shorter than the floral tube . . . . . 2. *C. carthagenensis*
   2. Floral tube purple-green, 6–10 mm long, villous within; stamens equal to or exceeding the floral tube.
      3. Leaves petiolate, 20–55 mm long; stems erect, much branched; upper calyx lobe largest . . . . . 3. *C. viscosissima*
      3. Leaves sessile, 7–17 mm long, stems mostly decumbent, unbranched or sparsely branched; calyx lobes equal in size . . 4. *C. glutinosa*

1. C. ASPERA Chapm.—Short-lived perennial, 2.5–4 dm tall, branched, with tuberous roots. Leaves sessile, mostly whorled, linear to lanceolate, 10–25 mm long, 1.5–5 mm wide. Flowers opposite or whorled, 7–9 mm long, pedicels 5–15 mm long; floral tube purple-green, bearing dense, appressed, non-glandular hairs and erect glandular ones, villous within, calyx lobes equal in size; petals 6, pale purple, the upper two largest; stamens equal to or exceeding the floral tube; seeds 3. ($n=24$). Summer. Pine flatwoods; cp. Fla. Endemic, known only from Franklin and Gulf counties, in the vicinity of Port St. Joe and Apalachicola. *Parsonsia lythroides* Small—S.

This is the only species of *Cuphea* in the United States with whorled leaves and opposite or whorled flowers. It is most closely related to the Brazilian *C. hyssopoides* St.-Hil.

2. C. CARTHAGENENSIS (Jacq.) Macbr.—Erect or sprawling, much-branched annual, 1–6 dm tall. Leaves opposite, shortly petiolate to subsessile, elliptic, 12–55 mm long, 5–25 mm wide. Flowers alternate, 4.5–6 mm long, pedicels 0–2 mm long; floral tube green, sparsely hispid, glabrous within, calyx lobes equal in size; petals 6, purple, subequal; stamens much shorter than the floral tube; seeds 4–8. (n=8) Summer-Fall. Moist sunny ditches and disturbed places; cp. NC, SC, Ga, Fla, Ala, Miss, La /Tex Also Mex-S.Am., Pacific islands. *Parsonsia balsamona* (Cham. & Schlect.) Stand.—S.

The most widely occurring species in the genus, *C. carthagenensis* is probably native to South America but has been reported from the Galápagos Islands, Hawaiian Islands, and as far west as the Fiji and Philippine islands. It is a relatively recent introduction into the United States. Small (1933) records its range as peninsular Florida. The earliest United States collections I have seen are from Onslow Co., N.C., 1923 (*Alexander s.n.*, UNC) and Highlands Co., Fla., 1925 (*Small* 12660, UNC). Collections of the species become much more common after 1950. Many of the early ones are misidentified as *C. viscosissima*.

3. C. VISCOSISSIMA Jacq. Clammy Cuphea, Blue Waxweed—Erect, much-branched annual, 1–6 dm tall, often the viscid upper stems purplish red. Leaves opposite, with petioles 3–15 mm long, ovate to mostly narrowly lanceolate, 20–55 mm long, 6–20 mm wide. Flowers alternate, 8–10 mm long, pedicels 1–5 mm long; floral tube deep purple-green, with dense purple viscid glandular hairs, villous within, the upper calyx lobe larger than the others; petals 6, the upper two largest, deep purple; stamens equal to or exceeding the floral tube; seeds 7–10. (n=6) Summer-Fall. Pastures, disturbed places; all prov. SE, except Miss, La /All, except Tex/ Also northward to NH, west through central Ohio, Ind, and Ill to Kansas. *Cuphea petiolata* (L.) Koehne—F, G. *Parsonsia petiolata* (L.) Rusby—S.

This species is the most common and widespread *Cuphea* in the United States.

4. C. GLUTINOSA Cham. et Schlect.—Short-lived perennial, erect to decumbent, sparsely branched, 1–4 dm tall, the stems and leaves often purple tinged. Leaves sessile, opposite, ovate-lanceolate to oblong, 7–17 mm long, 3–7 mm wide. Flowers alternate, 6–9 mm long, pedicels 0–3 mm long; floral tube purple-green with dense weak non-glandular hairs and sparser glandular ones, villous within, calyx lobes equal in size; petals 3–6, pale purple to purple, subequal or the upper two slightly smaller, early deciduous; stamens equal to or exceeding the floral tube; seeds (6–)8(–10). (n=14)[4] Spring and Fall. Open woods and pastures, cp. La /Tex/ Also S. Am.

A widespread South American species, first collected in the United States in 1884 in Vermilion Parish, Louisiana. It is now known also from the adjacent parishes of Acadia, Lafayette, and Iberia and from Jackson and Tyler counties, Texas. The species was overlooked by Small and is not included in his *Manual* (1933). It is not included in Correll and Johnston, *Manual of the vascular plants of Texas* (1970).

Occasional specimens of the Mexican *C. procumbens* Gómez Ortega are encountered in eastern United States herbaria. They are, to my knowledge, garden escapes that do not persist.

REFERENCES

BLACKWELL, W. H. 1970. The Lythraceae of Ohio. Ohio J. Sci. 70: 346-352.

CORRELL, D. S., and H. B. CORRELL. 1972. Aquatic and wetland plants of southwestern United States. Environmental Protection Agency. Water pollution control research series 16030 DNL 01/72. Washington, D.C. 1777 pp.

CORRELL, D. S., and M. C. JOHNSTON. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas. 1881 pp.

EWAN, J. 1952. Frederick Pursh, 1774-1820, and his botanical associates. Proc. Amer. Philos. Soc. 96: 599-628.

_____. 1955. Report on research grants. Amer. Philos. Soc., Year Book 1955: 160-163.

FERNALD, M. L. 1950. Gray's manual of botany. 8th ed. American Book Co., New York. 1632 pp.

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[4] The first report for this species is based on meiotic material from the following collection (MICH): La.; Lafayette Parish; ca. 2 mi NE of Milton, Mai 1972, *John Thieret s.n.*

GLEASON, H. A., and A. CRONQUIST. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand, Princeton, N.J. 810 pp.
GRAHAM, S. 1964. The genera of Lythraceae in the southeastern United States. J. Arnold Arbor. 45: 235-250.
KOEHNE, E. 1885. The Lythraceae of the United States. Bot. Gaz. 10: 268-277.
_____. 1903. Lythraceae. Das Pflanzenreich. IV. 216. 326 pp.
LEWIS, S. 1805. Georgia, drawn by S. Lewis, Map library, Univ. Georgia, Athens.
LONG, R. W. and O. LAKELA. 1971. A flora of tropical Florida. Univ. Miami Press, Coral Gables, Florida. 962 pp.
LOW, J. 1810. Georgia, from the latest authorities, 1810. A New and Complete Encyclopedia 4: 64. New York.
MASON, H. L. 1957. A flora of the marshes of California. Univ. California Press, Berkeley. 878 pp.
PURSH, F. 1814. Flora Americae Septentrionalis. 2 Vol. London.
RADFORD, A. E., H. E. AHLES, and C. R. BELL. 1964. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. 1183 pp.
— — — , C. R. BELL, J. W. HARDIN, and R. L. WILBUR. 1967. Contributors' guide for the "Vascular Flora of the Southeastern United States." Department of Botany, Univ. North Carolina, Chapel Hill. 20 pp.
SHINNERS, L. H. 1953. Synopsis of the United States species of *Lythrum* (Lythraceae). Field & Lab. 21: 80-89.
SMALL, J. K. 1933. Manual of the southeastern flora. Univ. North Carolina Press, Chapel Hill. 1554 pp.
THIERET, J. W. 1972. *Rotala indica* (Lythraceae) in Louisiana. Sida 5: 45.
TORREY, J., and A. GRAY. 1840. Lythraceae *in* A flora of North America 1: 479-483.
WEBB, D. A. 1967. Generic limits in European Lythraceae. Repert. Spec. Nov. Regni Veg. 74: 10-13.
_____. 1968. Lythraceae *in* Flora Europaea 2: 300-303.

THE IMPORTANCE OF REVISIONARY STUDIES IN PLANT SYSTEMATICS[1]

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Our understanding of the diversity and inter-relationships of plant life is based primarily upon the comparative data of revisionary studies. The information in descriptions, keys, and distribution maps, plus the interpretation of relationships based upon these data, all contained within the revisionary study, have contributed much to our attempts to classify and to determine the phylogeny of the plant kingdom. Understanding of these aspects of the plant world is one of the important goals of plant systematics. The success of the past suggests that future attainment of this goal probably cannot be reached without the completion of additional revisionary studies.

Despite the importance of revisions in systematic botany, plant systematics currently is undergoing a metamorphosis in which emphasis is being placed on investigations of the evolutionary process. Although I am personally very interested and excited about all aspects of evolutionary and populational biology, I am concerned about the present status of revisionary studies in plant systematics, especially because it seems that graduate students are being drawn into more experimental and theoretical areas. People earlier (e.g., Robinson, 1923; Just, 1954) have emphasized the need for sustained and increased levels of revisionary efforts, but in view of the present trend toward evolutionary biology I believe that a new statement is needed. The purpose of this paper, therefore, is: (1) to point out the contributions of revisionary studies to plant systematics, (2) to mention the challenges involved with doing good revisionary work, (3) to suggest some innovations in revisionary investigations, and (4) to emphasize the importance of revisionary studies in relationship to the current world ecological situation.

A FEW DEFINITIONS

From a very broad perspective, one can conveniently recognize three types of systematic studies: floristic, experimental (= biosystematic or evolutionary), and revisionary (including synopses and monographs). Many papers actually encompass several of these basic types, and sometimes it

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SIDA 6(2): 104–113. 1975.

is difficult to place a particular investigation into one of the three categories. Nevertheless, such a breakdown is useful for our discussion.

Floristic studies attempt to list and describe in various ways the plants of a particular region, from areas as small as state parks or counties to larger areas such as states, regions, nations, or even continents. To describe the plants (even the vascular plants) of a region is a large and difficult job, and the larger the geographic area covered, the more arduous the task becomes. As a result, the portrayal of inter-relationships among taxa in a flora is often somewhat superficial. This is to be expected and is essentially unavoidable.

Experimental investigations, on the other hand, usually focus on some aspect of the evolutionary process, such as hybridization, ecotypic differentiation, or reproductive isolation, to name a few examples. These studies often concentrate on a small number of taxa such as a species complex, and laboratory apparatus of some sort is often used (microscopes, computers, etc.). Most of these studies are not experimental in the strict sense but rather in the broad sense of using equipment that is regularly employed in experimentally-oriented research.[2]

Revisionary studies cover the middle-ground between floristic and experimental approaches by showing detailed relationships among taxa, usually at the generic level and below, based primarily on herbarium investigations, library studies, and field work. Morphology is the primary type of data used, but sometimes other data—such as chromosome numbers or chemical analyses—are included in a revisionary study.

An even finer division can be made by recognizing three types of revisionary studies: synopsis, revision, and monograph. The synopsis is a brief summary of relationships, and usually not all problems in the group have been clarified even by use of library and herbarium facilities. The synopsis, therefore, should be regarded as a pioneering effort. The revision is a more complete statement of relationships among the treated taxa, with full synonymy, lists of excluded taxa, descriptions, keys, distribution maps, citation of representative specimens, and pertinent critical comments. A monograph is essentially the same as a revision except that it has even more information of one sort or another, such as history, chemistry, phytogeography, cytology, or philosophy. In this paper when I speak in general about revisionary studies, I mean all three types of investigations.

Revisionary studies are central to the development of floristic and experimental projects. Floristic work draws heavily on previously published revisions for information on nomenclature, morphology, distribution, and the separation of difficult taxa. Experimental studies also depend strongly

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[2] The term "experimental taxonomy" was originally applied to studies that investigated the nature of species by means of reciprocal transplants (Clements and Hall, 1920); such studies *were* experimental in the strict sense. In the decades after its introduction, however, the term acquired a broader meaning (e.g., Clausen, Keck, and Hiesey, 1941) and thereafter became confused with "biosystematics" (Camp and Gilly, 1943).

upon revisions by focusing on the clarification of relationships that are still not well understood. Difficult taxonomic situations that may lead to experimental studies often result from the evolutionary dynamics of hybridization and/or introgression, inbreeding, and apomixis.

CONTRIBUTIONS OF REVISIONARY STUDIES TO PLANT SYSTEMATICS

I believe revisions to be useful in plant systematics primarily in four ways: (1) as a source of classifications, (2) as an aid to identification, (3) as a source of biological data, and (4) as a stimulus for further study. Each of these uses will be discussed in turn.

The most significant contribution of revisionary studies is as a source of hierarchies of classification. Classifications are fundamental to the growth and development of plant systematics by playing at least three important roles (in part from Warburton, 1967). First, from the classification one can infer ancestral evolutionary relationships (= phylogenies) among all the included taxa, which gives some idea of the patterns of evolution through long periods of time. Second, the classification allows the biological data presented in the revision (see discussion below) to be retrieved more easily because they are ordered in an hierarchical arrangement corresponding to the classification itself. Third, the classification allows for the prediction of unknown attributes of taxa included in the revision. For example, if certain pharmacologically-active compounds are found in one species, it can be predicted that the most closely related species in the classification might have the same or similar compounds.

Another important use of revisions is for identification purposes. Many types of people, such as wildlife specialists, herbarium curators, etc., desire to know the names of particular plants. If no modern flora exists for an area, or if the group in question is not adequately treated in an available flora, then workers will turn to the keys, distribution maps, and descriptions in the revisionary study for help.

The information contained in a revision—in descriptions, distribution maps, and statements on phenology and ecology—represents biological data on what the plants are like, how they differ from each other, where they grow, and when they flower. Many types of systematists—from horticulturists to phytogeographers—as well as other biologists, seek this information. Phytogeographers are so dependent upon up-to-date revisionary studies that very few meaningful phytogeographic interpretations can be made for genera that are not well understood from a revisionary perspective (Axelrod and Raven, 1972; Thorne, 1972). Many additional data such as nomenclature, discussions of generic relationships, and taxonomic history are usually included in revisions, but this information is generally of lesser interest except to floristic and other revisionary workers.

The revision also serves as a stimulus for further study. Because basic relationships are clearly outlined, other workers such as cytologists or anatomists may want to pursue an analysis of the relationships further.

The revision may prove to be very stimulating to an anatomist, for example, even though no specific anatomical problems are mentioned. The interest may develop simply from his having read the descriptions of the different species or having seen their distributional patterns. On the other hand, specific problems for further study may be emphasized deliberately in the paper. For example, a discussion of difficulties of classification brought on by suspected hybridization and introgression might well catch the interest of a cytogeneticist.

REQUIREMENTS FOR GOOD REVISIONARY WORK

Although admitting the value of revisionary studies, some botanists might not realize that significant differences exist in the quality of revisionary work produced. Considerable variations among finished revisions do prevail, however, even to the extent that some studies are so inadequate that they prove nearly worthless for those purposes I mentioned earlier. Asa Gray, almost a century ago (1875), put it this way (p. 353): "Easy as the work may seem, the number of botanists who are able to elaborate a genus and draw up fairly good botanical descriptions is wonderfully small. The thing is quite possible if mere literary compilation is intended; but something more than this is needed."

The general requirements for excellence in revisionary work apply basically to most descriptive sciences and to a lesser degree even to experimental sciences. Many criteria might be formulated for evaluating the ability of a revisionary worker (and, therefore, also the quality of his published revisions), but I have selected six of what to me seem the most important: (1) precision and thoroughness in gathering of comparative data of all types; (2) ability to recognize discontinuities in sets of comparative data (= pattern recognition); (3) ability to relate observed discontinuities in sets of data to the various fixed ranks of the taxonomic hierarchy; (4) precision and thoroughness of description of recognized taxa; (5) precision and thoroughness of documentation in literature, specimen citations, and nomenclature; and (6) precision, thoroughness, and clarity of expression in the final written treatment. These six general criteria must be kept in mind when pursuing each of the three major aspects of revisionary studies: field, library, and herbarium investigations. But in addition to these general criteria, specific requirements for excellence in each of these activities also must be considered.

Although the completion of field investigations is not absolutely essential for good revisionary studies, there is little doubt that all other factors being equal, the more field work a researcher is able to do, the better will be his resultant treatment. The value of field observations for the revisionary worker lies mainly in improving his ability to recognize discontinuities among local populations and to relate the resultant groups to categories in the taxonomic hierarchy. Refined classifications can be produced solely from herbarium material, as has been done by many workers in the past

(e.g., S. F. Blake, B. L. Robinson), but such studies tend to be myopic in their treatment of relationships.

Library investigations are very important primarily because revisionary studies have a strong historical orientation. Not only must past aspects of nomenclature be understood fully, but also the literature must be searched extensively for taxonomic opinions or dispositions that may bear on the present attempts at classification. To be skilled in library work demands traits characteristic of professional botanical bibliographers: knowledge of languages, familiarity with literature on itineraries and biographies of collectors, understanding of abbreviations of older taxonomic literature, familiarity with the *International Code of Botanical Nomenclature*, and—most importantly—patience.

Herbarium investigations likewise are a very important part of the revisionary effort. These center on the core of the revision proper, which is the development of concepts of taxa and their subsequent ranking. It is at this point that the natural ability of the taxonomist must show through. He must have the talent to recognize discontinuities in data sets, or to put this same idea another way, he must have a "taxonomist's eye." The recognition of discontinuities sometimes can be very challenging, especially if the group in question shows unusual patterns of variation. In these cases a strong background in evolutionary theory is most helpful, if not absolutely necessary, to correctly identify apomixis, hybridization, or ecotypic differentiation and to make the proper taxonomic dispositions. Furthermore, to be good in pattern recognition necessitates knowing something about the kinds of data that have been collected and whether or not they have been collected correctly and in sufficient quantity. A good understanding of the morphology of the group in question is therefore essential, as is the full understanding of other types of data, such as anatomy, cytology, or chemistry, that may be available for use.

INNOVATIONS IN METHODS OF REVISIONARY STUDY

As with any aspect of plant systematics, innovations in approaches to revisionary studies must occur periodically or the studies themselves will never approximate their full utility. The basic formats and methodologies for revisionary work have been around since the time of Linnaeus.[3] From that beginning the approaches have remained largely unchanged except for the use of additional types of data on which to base the classifications. Because over 2 centuries have passed since the appearance of the early revisionary literature, it is appropriate at this time to consider if changes might be beneficial.

Unlike most experimental systematic studies, the format for presentation of data in revisionary studies is very rigid. The reason for this rigidity de-

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[3] Although taxonomic studies with "revision" in the title did not appear until the late 19th century, the earlier world floras of Linnaeus and DeCandolle are clearly revisionary in format and perspective.

rives from the objectives or uses of the revision, for which ease of data retrieval is paramount. The descriptions, keys, lists of synonyms, citations of representative specimens, and distribution maps are effective ways to insure accessibility of information. Innovations in methods of revisionary study should therefore be concerned primarily with new ways to develop and process data necessary to fill the revisionary structure, rather than with developing a new structure altogether. Some space-saving changes in structure may be desirable, however, such as the substitution of data matrices for keys and descriptions (Solbrig, pers. comm.).

Teamwork as a means of speeding up completion of revisionary studies has been emphasized by Leenhouts (1968) and by Blair and Turner (1972), and I agree with their suggestions. In the past, some joint ventures have been very successful (e.g., B. L. Robinson and J. M. Greenman; M. Mathias and L. Constance), and these should serve to encourage others to follow suit in the future. It is realized that productive joint ventures rest with compatible personalities that cannot be forced, but perhaps more overtures can be made toward colleagues with whom collaboration might succeed.

The gathering together of library materials is now a much easier task than ever before. This does not mean that interpretation of data is any easier but simply that the relevant publications can be located more quickly through numerous indexes and obtained much faster through copy machines or on microform. Reader-printer machines now available allow for hard-copy to be obtained cheaply and rapidly from microform publications.

The gathering together of herbarium specimens also is much easier than ever before. With the publication of the recent edition of the *Index Herbariorum* (Holmgren and Keuken, 1974) the existence of collections from which loans may be made is now known to all workers, even those in isolated geographic regions. Furthermore, the availability of Inter Documentation Company (Zug, Switzerland) microfiche editions of herbaria from which loans are not permitted (e.g., Linnaean and DeCandolle herbaria) has made examination of these collections almost routine.

In my opinion, one of the most significant innovations in methods of revisionary study will come with the use of machine-assisted operations. Because many of the procedures used in revisionary work deal with data manipulation, data-processing machines are ideally suited for aiding this work. The following paragraphs explain briefly how these machines might be useful in some of the individual procedures.

The preparation of lists of representative specimens during the course of a revisionary study is a laborious, time-consuming, and error-prone task. To speed up this aspect of the work, in our laboratory we have developed a computer program (Meacham and Stuessy, 1974) that allows for specimens to be cited automatically once the data are on machine-readable cards. The details of this program will be reported elsewhere, but I should mention that the procedures for coding of data are so simple that any taxonomist can use the program with almost no prior knowledge of computers. An ad-

ditional step that we have not done, but that has been done already by some workers (Soper, 1964; Gómez-Pompa and Nevling, 1973; Adams, 1974), is plotting specimen localities by computer on a base map.

Another time-saving procedure is use of a flexowriter, which essentially is a typewriter that generates a punched paper (or magnetic) tape at the same time the first manuscript draft is produced. This machine is very useful for the typing of descriptions and other textual portions that are not likely to be highly modified after the initial draft. At the time of final manuscript production, the paper tape is used to produce an edited typescript with no detailed proofreading being necessary.

One more computer procedure that will help make revisionary work more efficient is the preparation of keys directly from descriptions. It remains to be seen whether computers can produce as good a key as a taxonomist can, but it is very clear that preliminary keys can be generated that might be further modified by the worker with a net saving of time. Although this is a complex manipulation for computers, and although we are still a long way from having truly serviceable algorithms, preliminary studies (Hall, 1970; Pankhurst, 1971, 1974; Morse, 1971; Pettigrew and Watson, 1973; Dallwitz, 1974) suggest that some of the difficulties will be overcome soon. This procedure need not involve additional laborious coding of descriptive data either, because once the data from the descriptions are on paper or magnetic tape, as with use of the flexowriter described above, they could be fed with proper conversion into the computer without additional manual coding.

RELATIONSHIP OF REVISIONARY STUDIES TO THE ECOLOGICAL CRISIS

With the growing realization that the world's biota is diminishing at an alarming rate primarily as a result of man's modification of the environment, a new term, the "ecological crisis," has been coined to dramatize this loss of organic diversity. Implicit in this concept is that organisms higher up in the food webs, such as man himself, eventually will be harmed by the loss of diversity at lower trophic levels. Many scientists have recognized this problem (e.g., Iltis, 1967; Fosberg, 1972; Holdren and Ehrlich, 1974), and many books have been written (e.g., Ehrlich, 1968; Johnson, 1970; Matthews, Smith and Goldberg, 1971) that speak to the dilemma and its resolution, at least in part.

Because the present decline in diversity of the world's flora is likely to continue in years ahead, the plant systematist is faced with the responsibility of deciding which types of studies now appear to be most useful or productive, not only in a restricted sense for systematic botany, but also for mankind in general. The plant systematist is in the unique position of possessing considerable knowledge about the world's flora, and therefore presumably also in a good position to evaluate the kinds of studies that are important to stress at this time. Because of personal biases, different plant

systematists might give different values to the various kinds of studies. We do, it is true, need more experimental studies to learn as much as possible about the evolutionary process before the key intermediate taxa become extinct. Likewise, we also need an increased effort in floristic studies so that at least we will have some idea of what plants grow in particular regions before the flora is decimated.

Although respecting these different viewpoints, I believe that the revisionary study is the type of investigation most needed at this time. Reasons for this position lie principally with my view of the revision as being central to all facets of systematic botany. Although floristic treatments sketch relationships among the included taxa, the depth of understanding in this type of study is necessarily limited and is not best suited for helping us understand phylogenetic and phytogeographic relationships of the groups concerned, nor for understanding mechanisms of speciation that have prevailed. Moreover, the floristic study may not clarify fully the nomenclatural problems, so that the names for the taxa themselves may not even be correct.[4] Experimental studies on small groups of species are also needed at this time, but unless we have an accurate understanding of the basic relationships of most plant species, it will be impossible to extrapolate from these few in-depth studies on the process of evolution to the probable patterns of evolution in other groups of taxa. Therefore, to help document the world's flora before it vanishes, I agree with Turner (1971) that plant systematists should give emphasis to revisionary investigations and, in particular, to encouraging students to pursue these endeavors.

Because of the above assessment of the importance of revisionary studies in systematic botany, especially at this point in time, I believe that we should give attention to the support of field endeavors that bear on these efforts. Two types of collecting programs will give maximum return in this direction: (1) those completed by the revisionary worker himself in any region of the globe and (2) those completed by the floristic worker in very obscure regions of the earth as yet untouched markedly by European man (e.g., Amazon basin of South America) or in areas in danger of immediate and irreversible destruction (e.g., Mexican highlands). The revisionary worker is in the best position to make critical collections and observations that will allow the most significant data to be obtained from his plant materials in the future. The floristic worker in obscure or threatened regions will serve the valuable function of collecting at least some materials that can be worked up at a later date as part of a revisionary investigation. I believe that both types of field programs are urgently needed.

CONCLUSION

The previous discussions have attempted to show that revisionary studies

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[4] I would agree that detailed and critical floras (of which few exist) avoid most of these limitations, but I contend that such works are basically revisionary in character because of their depth of coverage.

play a very important role in plant systematics. I have tried to indicate that being a productive and excellent revisionary worker involves many challenges, including acquiring knowledge in several diverse areas—from botanical bibliography to evolutionary theory. Such challenges should be pointed out to graduate students so that a larger number of them will become stimulated to pursue these endeavors. With the world's flora disappearing at an increasing rate, we need as many people as possible studying basic plant relationships before the plants themselves are completely extirpated. The hope is that we can obtain enough detailed information about the flora to give us a foundation for future studies leading to at least a partial understanding of phylogeny and evolutionary processes in the plant kingdom.

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REFERENCES

ADAMS, R. P. 1974. Computer graphic plotting and mapping of data in systematics. Taxon 23: 53-70.

AXELROD, D. I. and P. H. RAVEN. 1972. Evolutionary biogeography viewed from plate tectonic theory, pp. 218-236. *In* J. A. Behnke (ed.), Challenging biological problems: directions toward their solution. Oxford University Press, New York.

BLAIR, W. F. and B. L. TURNER. 1972. The integrative approach to biological classification, pp. 193-217. *In* J. A. Behnke (ed.), Challenging biological problems: directions toward their solution. Oxford University Press, New York.

CAMP, W. H. and C. L. GILLY. 1943. The structure and origin of species. Brittonia 4: 323-385.

CLAUSEN, J., D. D. KECK, and W. M. HIESEY. 1941. Experimental taxonomy. Carnegie Inst. Washington Year Book No. 40: 160-170.

CLEMENTS, F. E. and H. M. HALL. 1920. Experimental taxonomy. Carnegie Inst. Washington Year Book No. 18: 334-335.

DALLWITZ, M. J. 1974. A flexible computer program for generating identification keys. Syst. Zool. 23: 50-57.

EHRLICH, P. R. 1968. The population bomb. Ballantine Books, New York.

FOSBERG, F. R. 1972. The value of systematics in the environmental crisis. Taxon 21: 631-634.

GOMEZ-POMPA, A. and L. I. NEVLING, JR. 1973. The use of electronic data processing methods in the Flora of Veracruz program. Contr. Gray Herb. 203: 49-64.

GRAY, A. 1875. Bentham, on the recent progress and present state of systematic botany. Amer. J. Sci. Arts 9: 288-294, 346-355.

HALL, A. V. 1970. A computer-based system for forming identification keys. Taxon 19: 12-18.

HOLDREN, J. P. and P. R. EHRLICH. 1974. Human population and the global environment. Amer. Sci. 62: 282-292.

HOLMGREN, P. K. and W. KEUKEN. 1974. The herbaria of the world. Index Herbariorum. Part 1. Ed. 6. Regnum Veg. 92: 1-397.

HUTIS, H. H. 1967. To the taxonomist and ecologist whose fight is the preservation of nature. Bioscience 17: 886-890.

JOHNSON, C. E. 1970. Eco-crisis. John Wiley & Sons, New York.

JUST, T. 1954. Generic synopses and their role in modern botanical research. Taxon 3: 201-202.

LEENHOUTS, P. W. 1968. A guide to the practice of herbarium taxonomy. Regnum Veg. 58: 1-60.
MATTHEWS, W. H., F. E. SMITH, and E. D. GOLDBERG (eds.). 1971. Man's impact on terrestrial and oceanic ecosystems. The MIT Press, Cambridge, Mass.
MEACHAM, C. and T. F. STUESSY. 1974. Procedural innovations in revisionary studies: computer-assisted citations of representative specimens. Amer. J. Bot. 61: 47.
MORSE, L. E. 1971. Specimen identification and key construction with time-sharing computers. Taxon 20: 269-282.
PANKHURST, R. J. 1971. Botanical keys generated by computer. Watsonia 8: 357-368.
_____. 1974. Automated identification in systematics. Taxon 23: 45-51.
PETTIGREW, C. J. and L. WATSON. 1973. On the identification of sterile Acacias and the feasibility of establishing an automatic key-generating system. Austral. J. Bot. 21: 141-150.
ROBINSON, B. L. 1923. The need of monographic activity in American botanical taxonomy. Science 62: 307-310.
SOPER, J. H. 1964. Mapping the distribution of plants by machine. Canad. J. Bot. 42: 1087-1100.
THORNE, R. F. 1972. Major disjunctions in the geographic ranges of seed plants. Quart. Rev. Biol. 47: 365-411.
TURNER, B. L. 1971. Training of systematists for the seventies. Taxon 20: 123-130.
WARBURTON, F. E. 1967. The purposes of classifications. Syst. Zool. 16: 241-245.

NOTES

ADDITIONS AND CORRECTIONS TO THE FLORA OF TEXAS.—*Hibiscus esculentus* L. (Malvaceae). Milam Co.: river bottom, 1 mile E of Cameron. 30 Oct 1933. *Simon E. Wolff 4890* (SMU). This specimen is an escape of a particularly coarse strain of the widely cultivated Southern vegetable, okra.

Hydrilla verticillata (L. f.) Caspary (Hydrocharitaceae). Hays Co.: backwaters of San Marcos River, Southwest Texas State University campus, San Marcos. 27 Apr 1975. *Jerry M. Flook 104* (SMU). This nuisance introduction has become so abundant in the San Marcos River that it is now being harvested commercially and marketed statewide as an aquarium plant.

Lythrum salicaria L. (Lythraceae). Hardin Co.: almost in water of stream along roadside leading to Sour Lake, W of Hwy. 69. 25 June 1971. *Peggy A. Amerson & Geraldine E. Watson 540* (SMU). (See Sida 6(2): 100.)

Rudbeckia subtomentosa Pursh (Compositae) has been included in the Texas flora in Britton and Brown's *Illustrated Flora* (1897, 1913; Gleason 1952, New York Botanical Garden) and in Cory's *Catalogue of the Flora of the State of Texas* (Tex. Agric. Exp. Sta. Bull. No. 550, 1937). It has, however, been omitted in the more recent major treatments of the Texas flora, i.e., Gould's *Texas Plants—A Checklist and Ecological Summary* (Tex. Agric. Exp. Sta. MP-585, 1962; MP-585-Revised, 1969) and Correll and Johnston's *Manual of the Vascular Plants of Texas* (Tex. Res. Found., Renner, Tex., 1970). On the basis of the following collection *R. subtomentosa* should be reinstated in the Texas flora: Hardin Co., ditch bank along Ariola Rd. across from 100-1 Gun Club; pine savannah wetlands. 31 July 1974. *Geraldine Watson 1837* (SMU).

In his list of additions and corrections to the *Manual of the Vascular Plants of Texas* D. S. Correll (Amer. Mdl. Naturalist 88: 494. 1972) reports *Sabatia brachiata* L. (Gentianaceae) as new to the Texas flora. Inclusion of that species was based on a collection from Hardin Co., *Peggy A. Amerson & Geraldine E. Watson 161.* However, examination of this specimen in the S.M.U. Herbarium has revealed it to be *Sabatia campanulata* (L.) Torr., itself a new report for Texas. A second specimen from Hardin Co., *Amerson & Watson 637*, is also in the S.M.U. Herbarium. *Sabatia campanulata* is a plant of damp acid savannahs and boggy habitats and ranges through the southeastern states west to Arkansas and southeastern Texas.

Vicia hirsuta (L.) S. F. Gray (Leguminosae). Shelby Co.: near Center. *Simon E. Wolff, s.n.*, 11 May 1944 (SMU). This native of Europe is now found naturalized over most of the eastern half of the continental U.S.—*Jerry M. Flook, Herbarium, Southern Methodist University, Dallas, Texas 75275.*

SCHIZACHYRIUM STOLONIFERUM NASH VAR. WOLFEI DeSELM, VAR. NOV. (GRAMINEAE).[1]—Named for John Nicholas Wolfe, American

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botanist 1910-1974. —Haec planta ut in specie descripta praeter spiculam sessilem breviorem (5.1 mm.), aristam etiam saepe deficientem (ea pars brevis si praesens), atque spiculam pedicellarem (plerumque 1.8 mm.) et suam aristam (plerumque 0.8 mm.) breviores. Holotype, Florida, Osceola Co.: Four miles northwest of Loughman, *Ray, Lakela, Patman 10494*, 14 October 1960 (USF). The holotype appears to be of the same species as described by G. V. Nash, in Small, Flora of Southeastern United States, 1903. Exceptional characters are shorter (5.1 mm.) sessile spikelet length (averaging 6.3 mm. in the species,) awn absent to 7 mm. long, averaging 4 mm. (always present and averaging 6 mm. in the species), pedicellate spikelet length averaging 1.8 mm. (2.6 mm. in the species), its awn 0-1.5 mm., averaging 0.8 mm. (1.1 mm. in the species). DISTRIBUTION: sandhills, coastal strand and pine flatwoods, Central Florida: Charlotte, Collier, Highlands, Manatee, Osceola, and Pinellas Counties. This small spikeleted, often non-awned variety of *S. stoloniferum* Nash was recognized during a study of *Andropogon* and related genera for the projected "Manual of the Vascular Flora of the Southeastern United States." Other collections of *S. stoloniferum* var. *Wolfei* in DU, UNC, UF, USF have been examined and annotated.—*H. R. DeSelm, Botany Department and Graduate Program in Ecology, University of Tennessee, Knoxville, Tennessee 37916.*

HEMIGRAPHIS REPTANS (ACANTHACEAE), A GREENHOUSE WEED IN LOUISIANA.—The occurrence of *Hemigraphis reptans* T. Anders. as a greenhouse weed new to Florida was reported by Beckner in 1967 (Sida 3: 118-119). Shortly thereafter I noted the same species growing under the benches in the biology greenhouse at the University of Southwestern Louisiana at Lafayette. A visit to the other USL greenhouse (at the Horticulture Center) and to the commercial "Orchid Gardens" greenhouse in Lafayette revealed this rather drab Acanthacea growing as a weed there too. The *Hemigraphis* was still an innocuous weed in the biology greenhouse when I left USL (May 1973). The species can certainly be expected in areas other than Florida and Louisiana in the southeastern United States. The following collections will document the presence of *H. reptans* in Louisiana: LOUISIANA. Lafayette Parish: weed in USL biology greenhouse, corolla white with a pinkish tinge, leaves purplish below, 7 Jun 1969, *Thieret 31815* (SMU), 1 Apr 1973, *Thieret 48400* (KNK).—*John W. Thieret, Department of Biological Sciences, Northern Kentucky State College, Highland Heights, Kentucky 41076.*

BRAZORIA (LABIATAE) IN MEXICO—*Brazoria* Engelm. & Gray, a genus of four species, is closely allied to *Physostegia*. It has traditionally

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[1] Department of Botany, Contribution N.S. No. 446.

been considered endemic primarily to Texas, with only one extra-Texas report in literature (a collection of *B. scutellarioides* from Murray Co., Oklahoma [L. H. Shinners, 1953, Field & Lab. 21: 154]). The idea of Texas-Oklahoma endemicity of *Brazoria* must now be modified in light of a record of *B. scutellarioides* from Coahuila, Mexico: "15-285 km north of Saltillo," elevation 1,200 ft, in sandy caliche soil, 26 May 1966, *Robert Pearce 2129* (SMU). The habitat of the collection is consistent with the observed affinity of *B. scutellarioides* for well-drained rocky calcareous soils. This report extends the known range of *B. scutellarioides* 100-135 miles southward.—*Jerry M. Flook, Herbarium, Southern Methodist University, Dallas, Texas 75275.*

FATOUA VILLOSA (MORACEAE): ADDITIONAL NOTES ON DISTRIBUTION IN THE SOUTHEASTERN UNITED STATES.—Thieret (Sida 1: 245) first reported *Fatoua villosa* (Thunb.) Nakai in the United States based on a Louisiana collection. DuQuesnay (Sida 5: 286) added a Pasco County, Florida station in 1974. Since these reports I have noted that specimens have appeared in our herbarium from additional stations in the southeastern states.

We now have the opportunity to follow and study the spread of a new weed. The following citations, based on specimens deposited at NCU, indicate that this species is apparently being distributed by the transport of greenhouse plants and nursery stock. In some areas of the southeast, it is apparent that, once introduced, this species persists.

ALABAMA: Mobile Co. Weed in flower bed, Mobile, 10 Jul 1972, *Lelong 6638.*

FLORIDA: Leon Co. Weed in and around nursery beds, Capital Nursery, N. of Tallahassee, 20 Oct 1970, *Godfrey 70116.*

GEORGIA: Lowndes Co. Weed of flower beds and shrub borders at Castle Park Shopping Center in Valdosta, 20 Jun 1970, *Faircloth 6736.*

LOUISIANA: Concordia Parish. Haphazard Plantation off La. 566, Sec. 6, T8N, R8E, 11 Aug 1971, *Thomas et al. 24566.*
Ouachita Parish. Weed in flower pots in greenhouses, Roach's Nursery, west of West Monroe, 20 Dec 1969, *Thomas & Scarborough 17467.*

MISSISSIPPI: Forest Co. Greenhouse, Fisher's Flowers, 7th Street, Hattiesburg. 20 Mar 1972, *Rogers 7902.*

NORTH CAROLINA: Mecklenburg Co. Growing in old pots of *Tradescantia* outside greenhouse at UNC-C, Charlotte, 15 Oct 1973, *Matthews, s.n.*—*J. R. Massey, University of North Carolina, Chapel Hill, NC 27514.*

NEW AND VERIFIED ADDITIONS TO THE NEBRASKA VASCULAR FLORA.—Continued field and herbarium work has produced a number of new species for the state and has verified previous collections. All specimens cited are at the Nebraska State Herbarium (NEB).

Elymus junceus Fisch. Thurston Co.: 8.2 miles N. of Macy junction on Hwy 73, plant uncommon along roadside ditch on upland, 19 May 1973, *Churchill 690*. This introduced Eurasian grass is listed in only a few recent North American manuals.

Festuca arundinacea Schreb. Lancaster Co.: north side of Branched Oak Lake NW. of Lincoln, edge of marsh shore in disturbed ground, 11 August 1973, *Churchill 2355*. Introduced from Europe, this grass was probably planted but apparently spreading at sites.

Carex bushii Mack. Jefferson Co.: 5 miles S. of Fairbury on Hwy 15 & just E., seepage area on sandy grass-covered slope of north-facing bluff, 13 June 1974, *Churchill 3538A*. This extends the range north from eastern Kansas.

Carex frankii Kunth. Gage Co.: 1.5 miles S. of Rockford, at Rockford State Lake area, edge of intermittent pool, 13 June 1974, *Churchill 3569*. Richardson Co.: NE. quarter of S26, R18E, T1N, rich wet alluvial soil by shallow pond, 9 July 1974, *Shildneck C-6679*. An earlier collection of this species is Richardson Co.: River road 1.5 miles S. of Indian Cave, (3 miles E. & 2 miles N. of Barada) low swampy ground, 27 June 1940, *Reynolds 1553*. This extends the range north from eastern Kansas.

Carex trichocarpa Muhl. Burt Co.: 2.9 miles E. of Oakland on Hwy 32, along moist ditch between railroad tracks and highway, 18 June 1972, *Churchill 158*. This is an extension west from Iowa.

Scirpus georgianus Harp. *(Scirpus atrovirens* Willd. var. *georgianus* (Harp.) Fern.). Jefferson Co.: 5 miles S. of Fairbury on Hwy 15 & just E., on lower slope of north-facing bluff in wet sandy soil, 13 June 1974, *Churchill 3553*; .5 miles S. of Endicot, disturbed sandy wet ditch, 13 June 1974, *Churchill 3563*. Saline Co.: 3.8 miles N. of Wilber on Hwy 103, small creek marsh, 13 June 1974, *Churchill 3527*. This extends the range north from eastern Kansas.

Phlox paniculata L. Nance Co.: just S. of Fullerton on Hwy 14, along Loup River floodplain, in sandy soil at edge of young *Salix-Cornus* woods, 8 August 1974, *Churchill & Kaul 4579*. This cultivated plant is the first record collection for the state in the wild.

Aster subulatus Michx. var. *ligulatus* Shinners. Lancaster Co.: just W. of Lincoln at Oak Lake, very common along saline shore, with *Leptochloa* & *Eriochloa*, 3 September 1973, *Churchill 2652;* 7 October 1974, *Churchill 4579*. This aster extends the range north from central Kansas.

I am grateful to the following individuals for their verification or identification of specimens: Ole Kolstad on *Carex*, Ronald McGregor on *Aster*, Alfred Schuyler on *Scirpus* and David Sutherland on *Elymus* & *Festuca*.—
Steven P. Churchill, University of Nebraska State Museum, Lincoln, Nebraska 68508.

REVIEWS

FLOWERING PLANTS: EVOLUTION ABOVE THE SPECIES LEVEL. G. Ledyard Stebbins. XVIII + 399 pp., 59 figs. Belknap Press of Harvard Univ. Press, Cambridge, Mass. 1974. $18.50.

This is a very exciting—and busy—time for anyone teaching advanced angiosperm morphology, phylogeny, or phylosystematics. Within the span of a few months we have seen the publication of this book by Stebbins, the 2nd Edition of Foster & Gifford (Freeman & Co.), a new look at distributions by Raven & Axelrod (Ann. Mo. Bot. Gard. 61:539-673. 1974), and a new treatment of the old Ranales by Thorne (Aliso 8:147-209. 1974). This new literature is like "new bottles for old wine," with apologies to the late Sir Julian Huxley.

Professor Stebbins has given us a fantastic book. It is full of ideas, new answers for old nagging questions, as well as new questions, and it is delightfully readable. Only a person with his vast knowledge and *understanding* of plants both living and fossil, and his understanding of genetics, developmental biology, and ecology could achieve this degree of conceptualism. As he says, it is based upon fifty years of observation, experimentation, and reading hundreds of books and journal articles.

The book is divided into two parts. The first deals with "Factors that Determine Evolutionary Trends." In seven chapters he describes the basic evolutionary processes and argues for the concept of genetical uniformitarianism and the view that the same basic evolutionary processes give rise to all taxonomic levels from the races within a species to the higher categories. Concomitantly he argues against the necessity to conjure up a mechanism such as directed mutation pressure to explain those features of higher categories that have no apparent adaptive value, and for the necessity to consider the importance of internal selection for a genotype governing a harmonious course of development. Explanations are given for the maintenance of morphological similarities or constancy of characteristics of higher categories in face of random fluctuations in the environment interacting with random mutations. Certain adaptations are discussed at length. The second part, also in seven chapters, concerns hypotheses about the origin of angiosperms and phylogenetic trends, and the adaptations of various character states. His diagram of relationships of orders, subclasses and classes shows affinities, degree of specialization, relative size of groups, and the amount of divergence within each group. The last chapter suggests kinds of research that are needed in the future. Each chapter is provided with an excellent and concise summary of the salient arguments and hypotheses.

Undoubtedly the textbooks of the future will include such items as Stebbins' "corystosperm theory of angiosperm origin," "internal selection theo-

ry," and "principle of genetical uniformitarianism." His diagram of evolutionary relationships of angiosperm orders will be added to those by Bessey, Hutchinson, Cronquist, Takhtajan, etc. We will add to our everyday vocabulary such terms as "evolutionary cradles," "evolutionary museums," "evolutionary canalization" and others learned here. This is a monumental work which will have a tremendous and lasting impact on our field. It is indispensable to botanists and evolutionary biologists.

There are very few mistakes. My only criticism concerns the index. The book will obviously be used as a reference to Stebbins' views regarding evolutionary trends and adaptive significance of various features. Yet, the index is lacking in a number of references to such topics. For example, where is the discussion on the evolution of stipules? It could be in chapters 3, 9, 10, or 11 according to the Table of Contents. To help overcome this deficiency, a number of missing entries are given below. Some of these reflect a different choice of entry rather than a complete omission.

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LIST OF FLOWERING PLANTS IN HAWAII. Harold St. John. 519 pp. Memoir Number 1, Pacific Tropical Garden, Kauai, Hawaii, 1973.

List of Flowering Plants in Hawaii sold for $22.50, but all remaining unsold copies were damaged in a disastrous flood and now sell for $5 to $15 depending on their condition. This work is a *vade mecum* for the professional botanist and advanced student interested in the plant taxonomy of the Hawaiian Islands. The body of the book devotes pages 9 to 13 to Gymnospermae; 14 to 132 to Monocotyledones; 133 to 369 to Dicotyledones; 369 to 374 to "New Names or Combinations"; 375 to 378 to an addendum; and finally an index ending with page 519.

"The aim of this publication is to present a list of the flowering, or higher, plants known to be in the Hawaiian flora. For each is given the scientific and common names of the plant, genus, species, and infraspecific taxon. The name of the author of the scientific name is given in full or in abbreviation, and the date of publication is added. If the plant is restricted to one or more of the Hawaiian Islands, hence a native to that region, its scientific name is printed in bold face . . . and the islands where it occurs are listed. If it is native to the islands, but also to other regions, it is printed in bold face and is marked indig. . . . If it is an introduced weed, it is printed in Roman type . . . If the plant is described or mentioned in any of the four basic books on Hawaiian botany, those by Hillebrand, Rock, Degener, and Neal, a page reference to it is given. Since the date of publication of each scientific name is given, it would have been helpful also to have given the full reference to its place of publication. Although these references were verified, this detail is deemed beyond the scope of the present summary."

To be sure, full citation of species would have added to the cost and bulk of the volume and would have been quite unnecessary as such information, except for dates, is readily available in the *Index Kewensis*. For the reviewers, however, full citation of trinomials ignored by the *Index* would have enhanced still more the value of the *List* by saving the reader the drudgery of scouring a library for such obscure references.

Casual perusal of the index should alert the reader to check the orthography of names before using them. Of almost 8,000 approved in the *List*, well over a hundred go contrary to the *International Code of Botanical Nomenclature*.

To the reviewers the author's statement that endemic species and infraspecific taxa number 2,668 is patently absurd; nor are they at all in agreement that "The endemic, indigenous, and adventive plants in the flora have been well collected and are now quite well known." In fact it has long been their conviction that the flora of the Hawaiian Islands in Captain Cook's time in 1778 did not consist of a mere 2,668 taxa but of 20,000 or more likely

30,000! Diligent monographic work on historical specimens collected since David Nelson's botanizing during Cook's voyage, and diligent collecting and studying of the presently surviving flora, should enable us to know about half the elements that were living 200 years ago. An inkling of the reviewers' assertion of the number of taxa is shown, for example, by St. John's treatment of the genus *Cyrtandra* (Gesneriaceae), beginning on page 308. Note the tabulation for the major islands of the Hawaiian Archipelago:

ISLAND	NUMBER OF TAXA	SQUARE MILES	SUMMIT IN FEET
Oahu	128	604	4,045
Maui	29	728	10,025
Hawaii	23	4,030	13,792
Kauai	22	555	5,170
Molokai	13	260	4,970
Lanai	4	141	3,370

Cyrtandra taxa are partial to wet jungles, and these peter out above the inversion layer where the terrain becomes increasingly dry. This is at about 7,000 feet elevation. Hawaii and Maui, with high mountains, nevertheless have vast rainforests. Can it be true that they harbor but 23 and 29 *Cyrtandra* respectively? Though Kauai has about 50 square miles less area than Oahu, it has a somewhat greater elevation. This greater range in resulting temperature might well increase speciation. Kauai, according to the author, has 22 taxa to Oahu's 128! In fact, while Oahu with its 604 square miles has 128; the other five islands with a combined total of 5,814 square miles have only 91. The explanation for such discrepancies is not botanical but human.

Oahu has been the center of human activity for 200 years. It is the seat of the capital, Honolulu, where the Bishop Museum and the University are located. Most visiting botanists resided there and collected within easy walking, riding, or driving distance of the city. Teachers, not excluding the author of the *List*, scoured Oahu with their students week-ends and holidays for its botanical riches. The "outside islands," in contrast, alawys have been neglected. What wealth of plants must still be growing there unknown to man! What applies to *Cyrtandra*, relatively unknown in the Archipelago excepting on Oahu, applies more or less to the remaining native genera.

With this in mind, the reviewers appeal to the biological workers of the world to come to this Mecca to collect its neglected riches before "progress" destroys them. With the torch of knowledge feebly flickering during the last decade of questionable political ethics in Washington, federal funds for Hawaiian taxonomy have nigh dried up. Even the fabulous Marie C. Neal Herbarium is lying fallow in Honolulu for want of funds. As botanists cannot prevent the continuous slaughter of one endemic taxon after another,

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they should at least attempt to collect, preserve, and record as much of the Hawaiian flora as is still extant so that future generations shall better understand what a splendid Paradise their forebears lost.—*Otto & Isa Degener, Volcano, Hawaii.*

APPEAL

Appeal for support for the INDEX HOLMENSIS project.

The INDEX HOLMENSIS is an index of plant distribution maps with world-wide coverage. It is the only international bibliography on distribution of vascular plants in area and vegetation maps.

We have so far published four volumes, i.e. volume I, covering vascular cryptogams and gymnosperms, volume II containing *Monocotyledoneae* A-I, volume III *Monocotyledoneae* J-Z, and finally volume IV covering *Dicotyledoneae* A-B, together more than 1000 pages. We intend to continue to publish one volume each year. The total number of distribution maps so far published is estimated to about 400,000, all of which will all finally be listed in the index or it's supplement. Although the main work is at present done at the Swedish Museum of Natural History in Stockholm the indexing work is served by an international editorial board. Members of this board to some extent guarantee completeness of the file for their particular area.

Still, the number of area and vegetation maps published annually is growing rapidly owing to the increased importance that is felt for the geographic compound of plant taxa. Consequently, not only are there wide areas all over the world where the entire flora is mapped systematically, but mapping has become a common feature in monographs in different fields, as for instance economic botany, palaeo-botany, vegetational history, palynology, and last not least phytocoenology.

In order to keep the file for the INDEX HOLMENSIS and it's planned supplement volumes up-to-date we herewith ask our fellow botanists to inform us about their published maps and/or to send reprints of their publications. Needless to say, we shall also continue to supply all information on distribution maps so far not published in the INDEX HOLMENSIS to colleagues on request.

All correspondence should be addressed to:

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The Swedish Museum of Natural History
S-104 05 STOCKHOLM 50

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A BIOSYSTEMATIC SURVEY OF COREOPSIS IN EASTERN UNITED STATES AND CANADA

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Coreopsis (Compositae), a genus of about 132 species, is distributed through the Americas, the near Pacific islands, and Africa. In his revision of the genus, Sherff (1936) listed 114 species in 11 sections. Since that time a number of additional species have been described, mostly from South America and Africa. Sherff (1955) more recently treated North American *Coreopsis*, listing 55 species in 10 sections. My area of interest in the genus is those species in central and eastern United States and in Canada east of the Rocky Mountains (sections *Coreopsis, Silphidium, Eublepharis, Palmatae,* and *Calliopsis*). These sections include 35 of the 55 species native to North America.

The greatest concentration of United States species of *Coreopsis* is in the southeastern states, an area with no recent flora. The best available manual for the area (Small, 1933) includes a treatment of *Coreopsis* by Boynton that differs considerably from that of Sherff (1955). Both Boynton's and Sherff's treatments, classical in approach, did not include any standard experimental techniques (chromosome counts, hybridization, uniform environment studies, pollen stainability, etc.). With the exception of a small paper on two species by Shelton (1968) and my papers (Smith, 1968a, b; 1969a, b; 1971; 1972; 1973a, b, c; 1974a, b; 1975; Smith and Parker, 1971), little biosystematic work has been published on the eastern United States and Canadian *Coreopsis*.

I have been engaged in a biosystematic study of *Coreopsis* of the eastern United States and Canada for several years. While several interesting problems remain unsolved, sufficient biosystematic information has been gathered to present a general survey of the species. Taxonomic modifications from Sherff's and Boynton's treatments are supported by biosystematic data.

MATERIALS AND METHODS

Standard taxonomic and biosystematic methods were employed in the study.

Herbarium Studies. Herbarium specimens—over 9000 sheets—from many herbaria were borrowed for phenological, morphological, distribution, and habitat studies. Morphological measurements were taken mostly from this

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dried material. Types of most species were examined.

Field Studies. Trips to natural populations of most of the species were taken to observe the populations in the field, to gather herbarium specimens, to obtain living material for greenhouse studies, and to gather buds for chromosome counts and meiotic analyses. Several trips were taken to the southeastern states and to Texas. Living material of several species was obtained through the kindness of botanists at other institutions.

Greenhouse Studies. Rootstocks were transplanted to the greenhouse, or the species were raised from achenes in the greenhouse, and the morphology of the parental species was observed in this relatively uniform environment. Hybridizations of various species were attempted in many different combinations. Heads were bagged prior to anthesis; the bags were removed at mid-anthesis and the heads gently rubbed together; then the heads were re-bagged until seed set occurred (or until the peduncle dried in cases of the failure of hybridization). Most species of *Coreopsis* are self-incompatible, as judged by the failure of seed set where heads were bagged and simply left bagged. Several species showed a low level of self-compatibility when attempted hybridizations failed but one or two selfed achenes would develop. A few species were found to be fully self-compatible, and in these the attempted hybridizations were performed with the self-compatible species as the pollen parent. Luckily, many of the hybridizations failed; if a high proportion of the 595 possible combinations $\left[\frac{n(n-1)}{2}, \text{ lumping reciprocals}\right]$ had succeeded, I would have been completely swamped with hybrids. The 595 figure includes only species (not varieties or forms); inclusion of varieties and forms would push the number of combinations to well over 1,000.

Chromosome numbers of the parental stock were determined from buds fixed in a modified Carnoy's fixative (ethyl alcohol:propionic acid:chloroform; 3:1:1) by the anther squash technique in 1% propiocarmine stain. Pollen stainability was determined from a minimum of 300 grains in 1% aniline blue (water soluble) in 90% propionic acid. Those grains staining a deep uniform blue were counted as stainable, and pollen stainability was equated with fertility. Pollen diameter, from the outer wall to the opposite outer wall (excluding the spines), was measured in some species.

Where artificial hybridizations were successful, pollen stainability was determined for the F_1 and in most cases meiotic analyses at diakinesis were made. The F_1 hybrids were intercrossed and/or backcrossed to one of the parental species to produce an F_2 (BC_1) generation. The pollen stainability of the F_2 (BC_1) was determined. The morphology of the F_1 and F_2 (BC_1) was examined to check for possible Mendelian inheritance of particular characters. Voucher specimens of the parental species, F_1, and F_2 (BC_1) were deposited in the Herbarium, University of Arkansas.

RESULTS

In an effort to condense my treatment of eastern United States and Canadian *Coreopsis*, I present a key to the taxa, brief sectional descriptions, a list of the species with pertinent biosystematic data, and figures of the typical morphology and known distribution of the taxa. Some of the distribution of certain species in Missouri, Illinois, Indiana, and Wisconsin was taken from Steyermark (1963), Jones and Fuller (1955), Deam (1940), and Melchert (1961), respectively. The plants are drawn at a scale of about 0.5X; the achenes at a scale of about 6X. Detailed morphological descriptions would unnecessarily expand the paper; the descriptions presented by Sherff (1955) are generally adequate (although I frequently differ from him on the interpretation of the entities).

Key to *Coreopsis* of eastern United States and eastern Canada

a. Disk flowers apically 5-lobed, with 5 anthers; ligules either 4-5-(several-) toothed or essentially entire apically . . . . . b.

b. Ligules cuneate, sharply 4-5-(several-)toothed apically; leaves entire or pinnately auricled to compound . . . . . c.

c. Disk flowers dark reddish-purple apically; ligules yellow, commonly bearing a reddish-brown spot basally; outer phyllaries linear and as long or longer than inner phyllaries . . . . . d.

d. Median and upper leaves with narrow segments, the terminal leaflet of the median leaves more than three times as long as broad (ca. 1-3 mm wide); lower stem glabrous to slightly pubescent on internodes . . . . . 1. *C. wrightii*

d. Median and upper leaves with broad segments, the terminal leaflet of the median leaves mostly less than three times as long as broad (ca. 5-15 mm wide); lower stem commonly pubescent to densely pubescent, sometimes slightly pubescent on the internodes . . . . . 2. *C. basalis*

c. Disk flowers yellow; ligules yellow, in two species commonly with several reddish-brown flecks a little above the base; outer phyllaries lanceolate to triangular or oblong, shorter than or about equal the inner phyllaries . . . . . e.

e. Ligules dark yellow basally, lighter yellow apically, commonly with several reddish-brown flecks a little above the base . . f.

f. Inner phyllaries dorsally pubescent; median and lower stem commonly glabrous (sometimes sparsely pubescent) . . . . . 3. *C. nuecensis*

f. Inner phyllaries dorsally glabrous; median and lower stem commonly densely (sometimes sparsely) pubescent . . . . . 4. *C. nuecensoides*

e. Ligules uniformly yellow, never reddish-brown flecked . . . g.

g. Stems with 1-5 (rarely 6 or more) cauline nodes below the first

head (begin count with the first node at least 1 cm above the basal leaves and include nodes bearing bracts near or on the peduncle) . . . . . h.

h. Stems with 1-3 cauline nodes; blades (or terminal leaflets) broadly elliptical to ovate-orbicular; outer phyllaries oblong to spatulate; mature achenes with narrow involute cartilaginous wing . . . . . 5. *C. auriculata*

h. Stems with 2-5 (rarely more) cauline nodes; blades (or terminal leaflets) oblanceolate to linear-lanceolate; outer phyllaries ovate to triangular-lanceolate; mature achenes with broad spreading membranaceous wing . . . . . 6. *C. lanceolata*

g. Stems with (5-)6-12 or more cauline nodes below the first head . . . . . i.

i. Leaves entire to 2-(4-) auricled . . . . . j.

j. Leaves commonly entire, sometimes with 2-4 narrow linear to oblong auricles near the base, the blades oblong to elliptical-oblong, the upper leaves sessile and relatively broad-based . . . . . 7. *C. intermedia*

j. Leaves commonly 2-auricled (sometimes entire), the terminal leaflet (or blade, in entire leaves) narrowly to broadly elliptical or oblanceolate, the auricles elliptical to falcate, the upper leaves petiolate to subsessile and narrowed at the base . . . . . k.

k. Blades (or terminal leaflets) narrowly to broadly elliptical and acute or oblanceolate and acuminate; stout-stemmed glabrous or pubescent plants of mostly inland range, the stem little or not at all branched basally . . . . . 1.

1. Blades (or terminal leaflets) more or less broadly elliptical, ca. 1.5-4 cm wide, acute; stem, and often one or both surfaces of the leaves, rather densely hairy . . . . . 8a. *C. pubescens* var. *pubescens*

1. Blades (or terminal leaflets) narrowly elliptical to oblanceolate, ca. 0.6-2 cm wide, acuminate; stem and leaves glabrous . . . . . 8b. *C. pubescens* var. *robusta*

k. Blades (or terminal leaflets) narrowly oblanceolate, acute; wiry-stemmed commonly glabrous plants of the Gulf Coast, the stem much-branched basally in mature specimens . . . . . 8c. *C. pubescens* var. *debilis*

i. Leaves pinnately compound with the leaflets entire to deeply more or less lobed . . . . . m.

m. Larger divisions of the median and upper leaves relatively broad, ca. 2-6 mm or more wide; achene wings entire;

pappus represented by two tiny fimbriolate teeth ca. 0.2-0.3 mm long . . . . . n.

n. Stem and flat surfaces of the blades glabrous . . . . . 9a. *C. grandiflora* var. *grandiflora* f. *grandiflora*

n. Stem and flat surfaces of blades rather densely pubescent . . . . . 9b. *C. grandiflora* var. *grandiflora* f. *pilosa*

m. Plant not thus: divisions of median and upper leaves narrower, or achene wings irregularly fimbriate, or pappus teeth ca. 0.5-1 mm long . . . . . o.

o. Achene wings irregularly fimbriate; lower stem often deep purplish; plants commonly limited to granite or sandstone outcrop areas . . . . . 9c. *C. grandiflora* var. *saxicola*

o. Achene wings entire; lower stem green or slightly purplish; plants commonly growing in sandy or gravelly roadside loam or on sandy hillsides, sometimes found in sandstone outcrop areas . . . . . p.

p. Divisions of median and upper leaves narrowly linear to filiform, ca. 0.5-1.5 mm wide; pappus teeth ca. 0.2-0.3 mm long; plants of wide distribution, most abundant in the Arkansas-Oklahoma-Missouri area . . . . . q.

q. Stems and segments of leaves essentially glabrous; general distribution . . . . . 9d. *C. grandiflora* var. *harveyana* f. *harveyana*

q. Stems and segments of leaves rather densely pubescent; endemic to Arkansas . . . 9e. *C. grandiflora* var. *harveyana* f. *demareei*

p. Divisions of the median and upper leaves linear to oblong or oblanceolate, ca. 2.5-5 mm wide; pappus teeth ca 0.5-1 mm long; plants endemic to Texas . . . . . 9f. *C. grandiflora* var. *longipes*

b. Ligules elliptical, entire or slightly 2-3-toothed at the very tip; leaves simple to palmately lobed or compound (in some species, the three leaflets are lobed to pinnatifid) . . . . . r.

r. Leaves simple and serrate . . . . . 10. *C. latifolia*

r. Leaves simple and entire to (commonly) palmately lobed to compound . . . . . s.

s. Leaves clearly petiolate, the petioles commonly 1-5 cm long . . . . . 11. *C. tripteris*

s. Leaves superficially appearing sessile, tapering gradually and no definite petiole evident, or born from a short petiole less than 1 mm long . . . . . t.

t. Leaves tapering gradually into a petiole-like base that bears three prominent parallel veins, the major leaves palmately lobed but not compound . . . . . 12. *C. palmata*

t. Leaves simple or (commonly) palmately compound with three leaflets (the leaflets simple to lobed or pinnatifid), subsessile from a tiny (less than 1 mm long) petiole that bears a single vein . u.

u. Leaves simple or (commonly) palmately compound, the leaflets entire (rarely the middle leaflet apically 2- or 3-lobed), the middle leaflet of the median leaves ca. 8-30 mm wide . . . v.

v. Outer phyllaries and flat portions of the blades rather densely short-pubescent . . . . . 13a. *C. major* f. *major*

v. Outer phyllaries and flat portions of the blades slightly pubescent to essentially glabrous . . 13b. *C. major* f. *oemleri*

u. Leaves palmately compound, the leaflets simple to lobed or pinnatifid, the segments of the median leaves ca. 0.5-7 mm wide . . . . . w.

w. Leaflets simple to (commonly) lobed, the segments of the median leaves ca. 2-7 mm wide . . 14. *C.* ×*delphinifolia*

w. Leaflets pinnatifid, the segments of the median leaves ca. 0.5-1.1 mm wide . . . . . x.

x Fresh disk flowers reddish-brown apically; internodes short so that leaves commonly overlap; leaf segments slightly enlarged toward the apex; rare plant of the mountains of northeastern Alabama (and perhaps northwestern Georgia) . . . . . 15. *C. pulchra*

x. Fresh disk flowers yellow; internodes longer so that the leaves do not (or scarcely) overlap; leaf segments linear; common plant of lower elevations from Virginia to South Carolina . . . . . 16. *C. verticillata*

a. Disk flowers apically 4-lobed, with 4 anthers; ligules bluntly 3-lobed apically (the middle lobe sometimes slightly notched or somewhat erose) . . . . . y.

y. Fresh ligules rosaceous to lavender or whitish; disk flowers yellow . z.

z. Leaves opposite, born well up the stem; stems born from rhizomes; achenes wingless . . . . . 17. *C. rosea*

z. Leaves alternate, juncoid, mostly basal; stems born from corm-like base; achenes with pectinate wings . . . . . 18. *C. nudata*

y. Fresh ligules yellow to orange (with or without a reddish-brown basal

spot); disk flowers apically reddish-purple . . . . . A.

A. Leaves simple, entire or bearing a few auricles near the base . . B.

B. At least the lower 1-few cauline leaves or all of the major cauline leaves alternate . . . . . C.

C. Fresh lower leaves clearly exhibiting numerous tiny dark dots in transmitted light (dots not always clearly evident in dried specimens); heads rather small, commonly 2.5-4 cm in diameter (measured from one ligule tip to the opposite ligule tip); commonly with the lower 1-few leaves alternate and the median and upper leaves opposite . . . . . 19. *C. linifolia*

C. Fresh lower leaves lacking numerous tiny dark dots in transmitted light; heads larger, commonly 3.5-6.0 cm in diameter; all major cauline leaves alternate (some of the bracts in the inflorescence may be opposite) . . . . . D.

D. Outer phyllaries deltoid, ca. 0.6-1.2 as wide as long, ca 0.2-0.3 the length of the inner phyllaries . . . . . 20. *C. floridana*

D. Outer phyllaries lanceolate to narrowly oblong, ca. 0.3-0.6 as wide as long, ca. 0.4-0.8 the length of the inner phyllaries . E.

E. Larger leaves strictly entire, rather leathery, glabrous to rather densely pubescent on the flat surfaces of the blade; achene wing ca. 1/4 to 1/2 as wide as the achene body; plants blooming September-November . . . . . 21. *C. gladiata*

E. Larger leaves often bearing 1-few auricles near the base (but also often entire), firm but not leathery, glabrous; achene wing ca. 3/4 as wide to equal the width of the achene body; plants blooming late May-June (rarely also in September) . . . . . 22. *C. falcata*

B. All of the major cauline leaves opposite . . . . . F.

F. Blades elliptical to ovate, the margin ciliolate, the flat surfaces often somewhat pubescent . . . . . 23. *C. integrifolia*

F. Blades linear to linear-oblanceolate, the margin and flat surfaces glabrous . . . . . G.

G. Fresh leaves more or less fleshy, the lower ones clearly exhibiting numerous tiny dark dots in transmitted light (dots not always evident in dried material); achene wing narrow, dissected . . . . . 19. *C. linifolia*

G. Fresh leaves not fleshy, lacking tiny dark dots in transmitted light; achene wing broad, entire . . . . 24. *C. leavenworthii*

A. Leaves pinnately to bipinnately lobed to compound . . . . . H.

H. Ligules entirely yellow; median leaves commonly simple to pinnately lobed; outer phyllaries in the bud stage appressed; plants endemic to Florida . . . . . 24. *C. leavenworthii*

H. Ligules commonly bearing a reddish-brown spot basally, infrequently entirely yellow; median leaves pinnately compound; outer

phyllaries in the bud stage loose, not appressed; plants of general distribution but rare in Florida . . . . . I.

I. Plants mostly 3-10 dm tall, not much branched basally; achenes winged or wingless; achene aristae represented by two tiny teeth ca. 0.1-0.2 mm long; plants of general distribution 25a. *C. tinctoria* var. *tinctoria*

I. Plants mostly 1-3 dm tall, much branched basally; achenes winged; achene aristae ca. 0.2-1 mm long; plants of southern Texas and adjacent Mexico . . . . . 25b. *C. tinctoria* var. *similis*

I. Section COREOPSIS (as sect. *Eucoreopsis.*) Nutt., Trans. Amer. Philos. Soc. II. 7:357. 1841.

Coreopsoides Moench, Meth. 594, as genus. 1794.

Anacis Schrank (in part: *A auriculata*), Denkschr. Königl. Akad. Wiss. München 5 (Math. Naturw.):5, as genus. 1817.

Leachia Cass., Dict. Sci. Nat. 25:388, as genus. 1822.

Chrysomelea Tausch, Hort. Canal. (15), as genus. 1823.

Sect. *Chrysomelea* Nutt., Trans. Amer. Philos. Soc. II. 7:357. 1841.

Sect. *Calliopsis* (Reichenb.) Nutt. (in part: *C. drummondii*), *sensu* T. & G., Fl. N. Amer. 2:345. 1842.

Sect. *Leachia* (Cass.) A. Gray, Syn. Fl. N. Amer. I^2 :291. 1884.

Subg. *Eucoreopsis* F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Sect. *Lanceolatae* F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Sect. *Tinctoriae* F. Boynton (in part), *in* Small, Man. SE. Fl. 1446. 1933.

Herbaceous perennials to annuals; leaves opposite, simple and entire to auricled or pinnately compound; ray flowers golden-yellow (the ligule in some species reddish-brown flecked or spotted basally), the ligule cuneate and 4-5-(several-)toothed at the apex; disk flowers golden-yellow (or reddish-purple apically), 5-toothed with 5 anthers, the style tips deltoid in outline; palea attenuate, deciduous; achenes obcompressed, the outer ones ca. 1.3-4 mm long, winged (the wing incurved and cartilaginous or represented by a ring of callus in some species), papillate on one or both surfaces, commonly bearing conspicuous callus spots near the apex and base on the ventral surface, the aristae represented by two minute (commonly less than 0.5 mm) fimbriolate teeth. $x = 13, 10, 9, 7, 6$ (Smith, 1975).

1. C. WRIGHTII (A. Gray) H. M. Parker *in* Smith, Bot. Gaz. 136: 82. 1975.

Coreopsis drummondii T. & G., *sensu* A. Gray (misapplied), Pl Wrightianae 1: 109. 1852.

Coreopsis drummondii T. & G. var. *wrightii* A. Gray, Syn. Fl. N. Amer. I^2: 291. 1884.

Coreopsis basalis (Otto & Dietr.) Blake var. *wrightii* (A. Gray) Blake, Proc. Amer. Acad. Arts 51: 526. 1916.

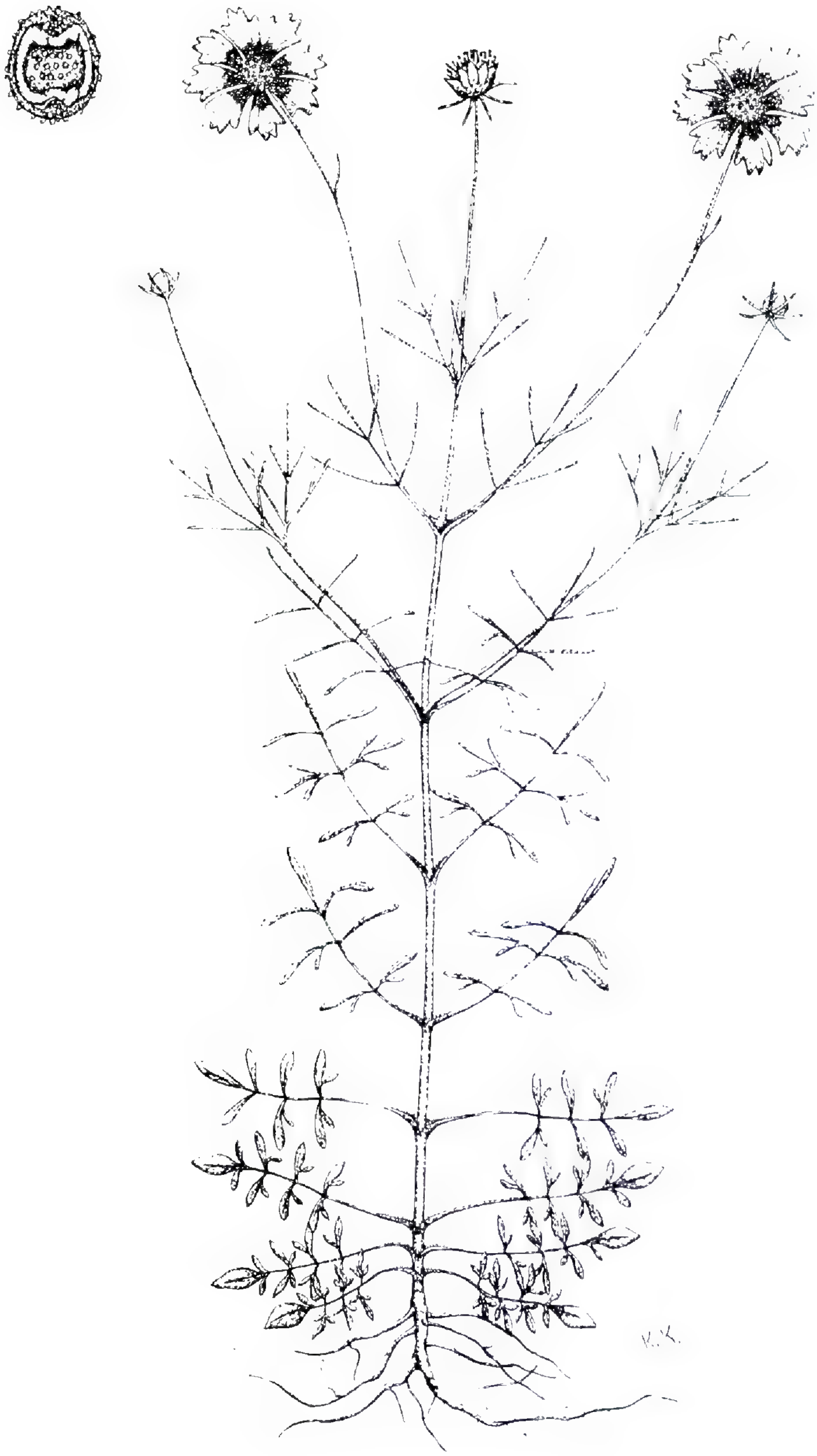


Fig. 1. *Coreopsis wrightii*; achene at upper left.

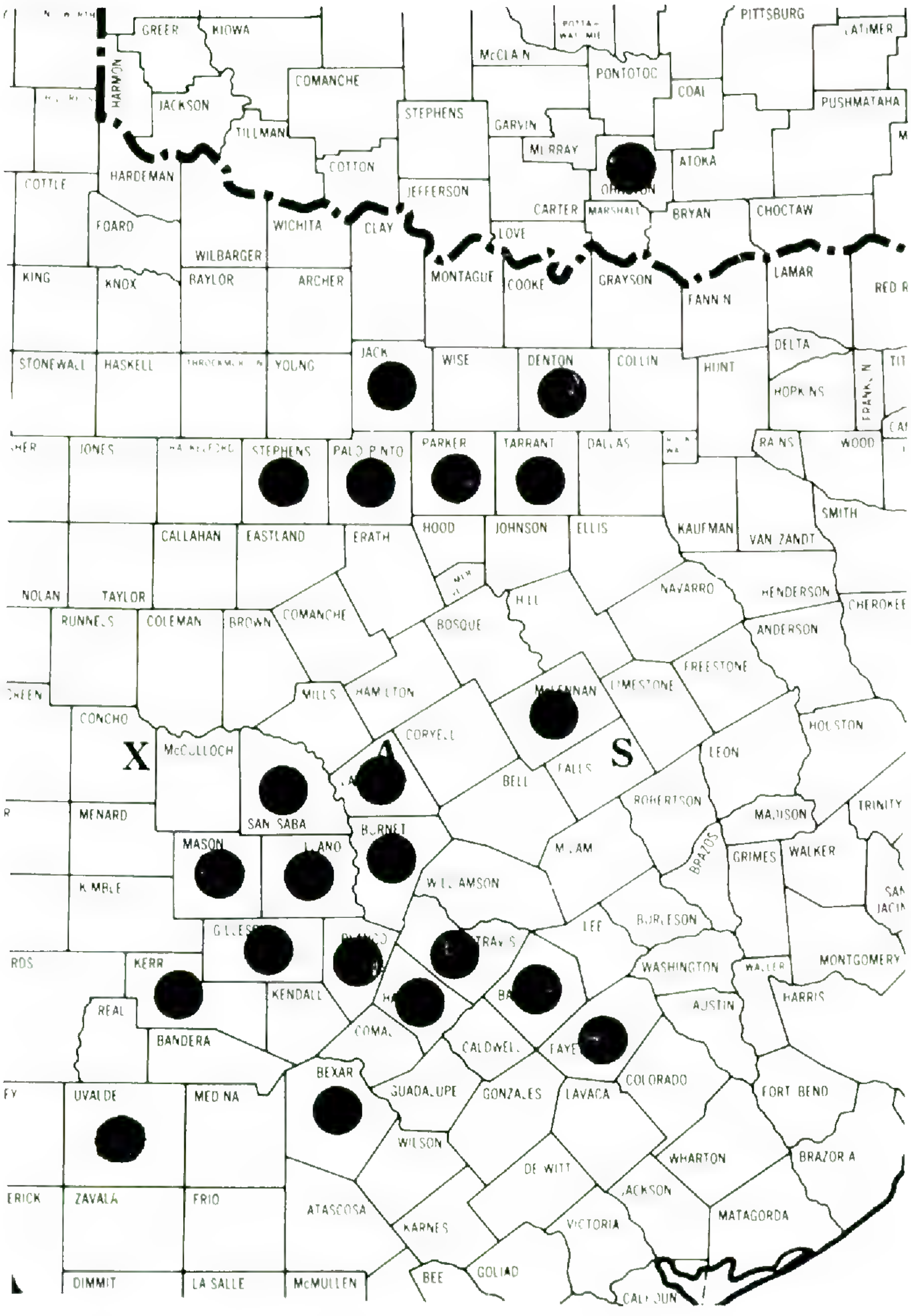


Fig. 2. Distribution of *C. wrightii* (central Texas to southern Oklahoma).

TYPE: United States: Texas, Uvalde County, *Wright 1237*, prairies of the Leona-Nueces (HOLOTYPE GH!). According to Wright's field notes (SMU copy), Wright's number 52 was collected on 15 May 1851.

Blooming: May-Jun. Habitat: Lower sandy areas, especially near granite outcrops. Chromosome number: $n = 13$.

This species (Fig. 1; Fig. 2) was misplaced by previous workers in section *Calliopsis*, as a variety of C. *basalis*. One of my former doctoral students did a biosystematic study of section *Calliopsis* (Parker, 1973), includ-

ing *C. basalis* and *C. rosea*. His work conclusively showed that *C. basalis* should be transferred to section *Coreopsis* and that var. *wrightii* should be elevated to species level. *Coreopsis wrightii* has the same chromosome number ($n = 13$) as the most common base number in section *Coreopsis*, while species of section *Calliopsis* are $n = 12$. Hybridization attempts of *C. wrightii* with *C. rosea, C. gladiata, C. tinctoria* (var. *tinctoria*, var. *similis*, and var. *atkinsoniana*) and *C. leavenworthii* failed.

Hybridization of *C. wrightii* with *C. basalis* was successful at a low level. Three F_1 hybrids averaged 0.6% pollen stainability and at diakinesis exhibited 2^{I}, 7^{II}, 2^{III}, 1^{IV}, indicating considerable structural differentiation between the two chromosomally. No F_2 was obtained.

Hybridization with *C. nuecensis* was also slightly successful. Four F_1 hybrids averaged 1.3% pollen stainability. The F_1 hybrids exhibited the inner phyllary pubescence of *C. nuecensis* and the reddish-brown ligule spot of *C. wrightii* (somewhat diluted in one plant) and had pale to dark reddish-purple disk flowers (yellow characteristic of *C. nuecensis;* dark reddish-purple characteristic of *C. wrightii*).

2. C. BASALIS (Dietr.) Blake, Proc. Amer. Acad. Arts 51:525. 1916.

Calliopsis basalis Dietr. *in* Otto & Dietr., Allg. Gartenzeitung 3:329. 1835 (Oct.).

Calliopsis drummondii D. Don *in* Sweet, Brit. Fl. Gard. II. *pl.* 315. 1835 (Dec.).

Coreopsis diversifolia Hook., Bot. Mag. *pl.* 3474, excl. syn. Elliott. 1836. [not *C. diversifolia* DC., which = *C. auriculata* L.; nor *C. diversifolia* Jacq., which = *Bidens serrulata* (Poir.) Desf.]

Coreopsis drummondii T. & G., Fl. N. Amer. 2:345. 1842.

Coreopsis basalis var. *typica* Sherff, Brittonia 6:341. 1948.

TYPE: I am here designating the following neotype: United States: Texas: Chambers Co., *Shinners 7717* (NEOTYPE MO!; ISONEOTYPE SMU!).

Blooming: May-Jul. Habitat: Low sandy areas. Chromosome number: $n = 13$.

A species (Fig. 3) very similar morphologically to *C. wrightii* but intersterile with it (see discussion under *C. wrightii*) and occupying a different range (Fig. 4).

Coreopsis basalis was apparently only recently introduced in the eastern U.S. (Ahles *et al.*, 1958) but is now widespread on the Coastal Plain from Florida to North Carolina (Fig. 4).

Attempted hybridizations of *C. basalis* with *C. grandiflora* (var. *grandiflora* and var. *saxicola*), *C. auriculata, C. rosea, C. tinctoria* (var. *tinctoria*, var. *similis*, and var. *atkinsoniana*) all failed. *Coreopsis basalis* also would not hybridize with *C. wrightii* when *C. basalis* was the egg parent, but did so with *C. basalis* as the pollen parent.

A small number of F_1 hybrids were obtained in crosses of *C. basalis* with

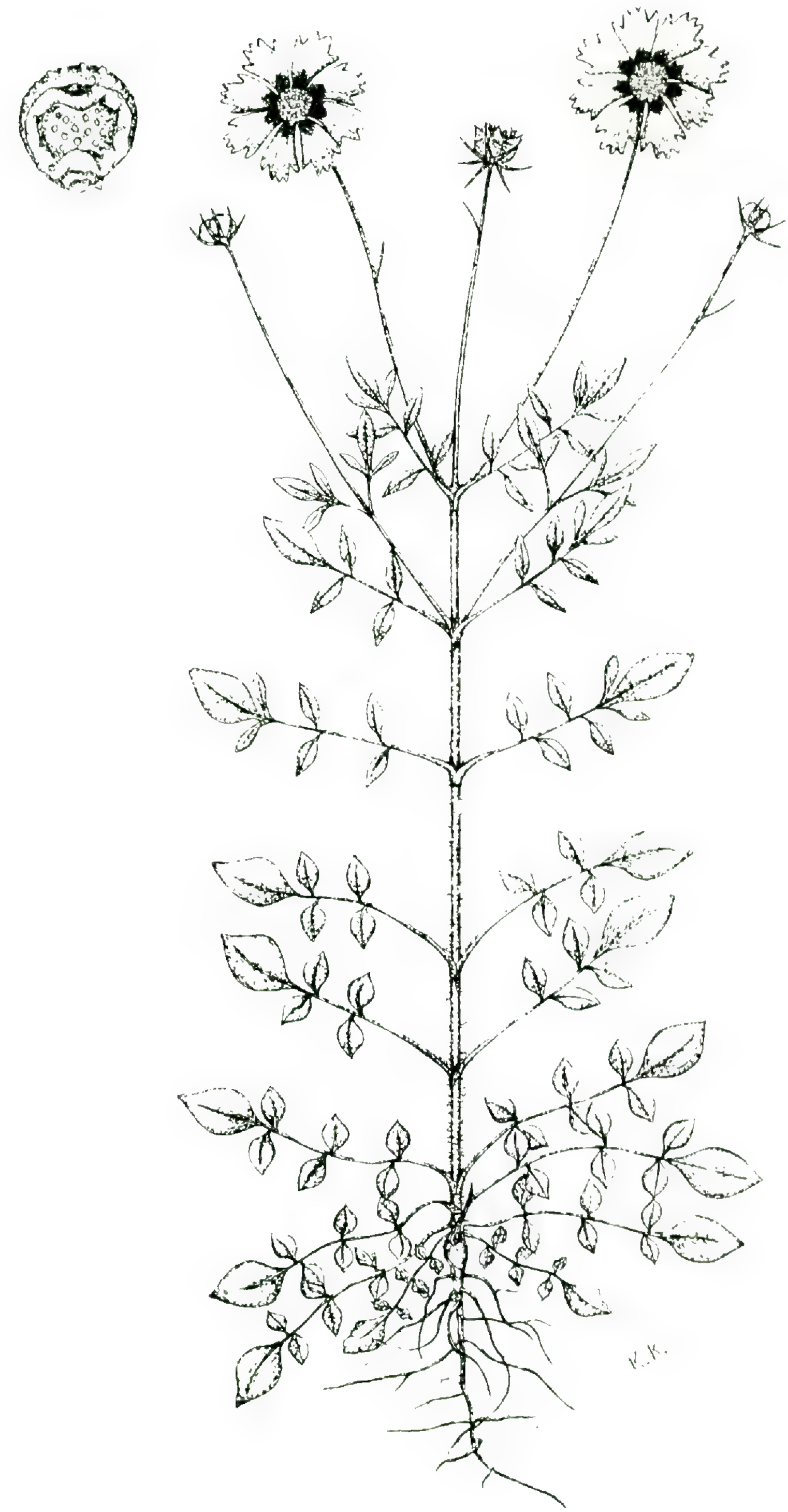


Fig. 3. *Coreopsis basalis*; achene at upper left.

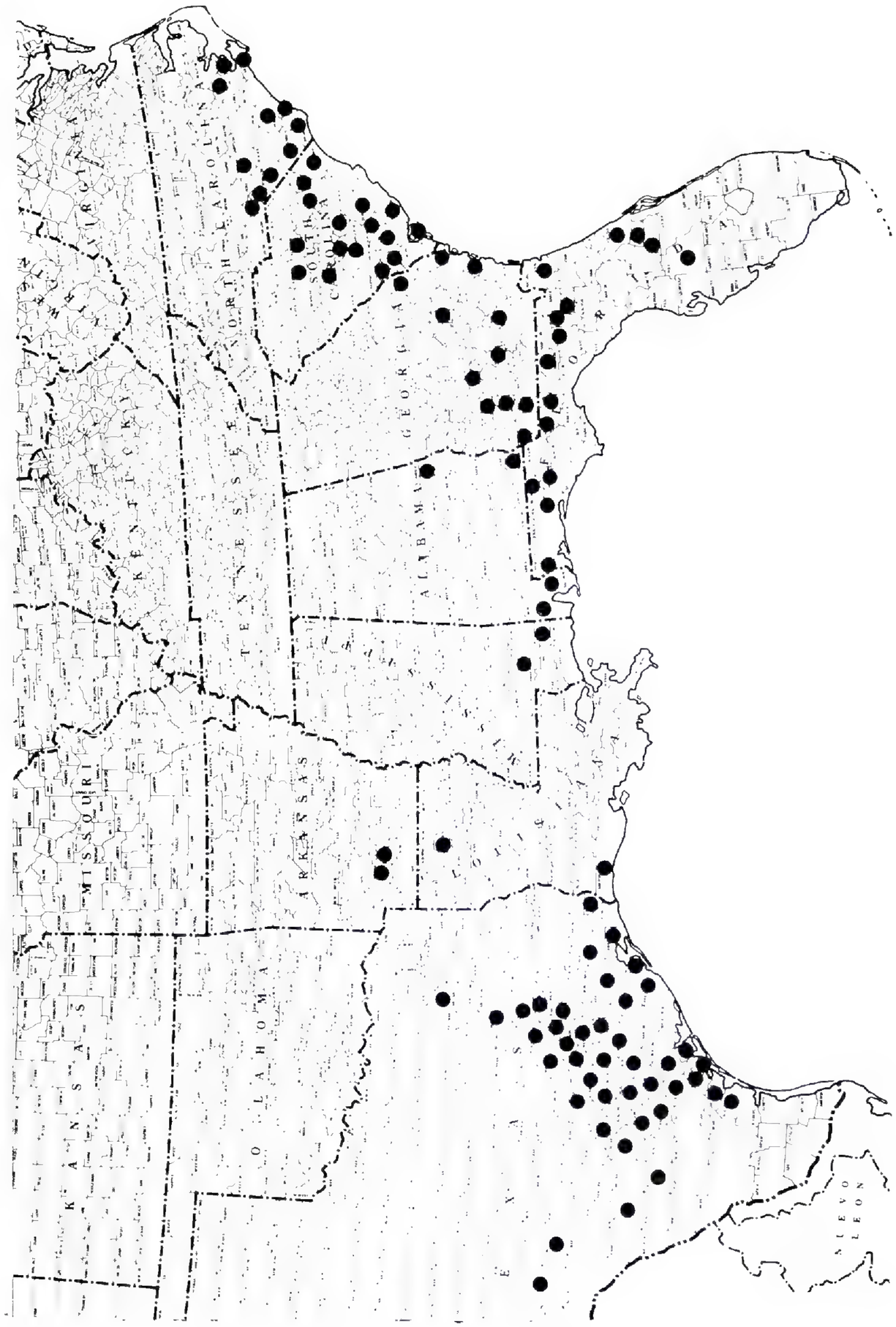


Fig. 4. Distribution of *C. basalis*.

backcross hybrids of a *C. grandiflora* var. *harveyana* × var. *saxicola* cross. Two of these F_1 hybrids averaged 10.5% pollen stainability. The hybrids exhibited the reddish-brown ligule spot of the *C. basalis* parent but were perennial as in the *C. grandiflora* parent (Smith, 1974b).

A small number of F_1 hybrids were produced between *C. basalis* and *C. nuecensis*. Two of these averaged 0.3% pollen stainability and exhibited various meiotic figures at diakinesis, including $n = 1^{III}, 1^{IV}, 1^{XII}$. The hybrids had pubescent inner phyllaries as in *C. nuecensis* and reddish-brown ligule spots as in *C. basalis*; one had yellow disk flowers (as in *C. nuecensis*), the other had dark purplish-red disk flowers (as in *C. basalis*).

3. C. NUECENSIS A. Heller, Bot. Expl. Texas 106. 1895.

Coreopsis coronata Hook., Bot. Mag. *pl.* 3460. 1836. (not *C. coronata* L. and others).

TYPE: United States: Cult. 1835 from Texas (HOLOTYPE KEW!).

Blooming: Mar-May. Habitat: Sandy ditches and fields. Chromosome number: $n = 6, 7$ (+ 0-2 B). Fig. 5, 6.

This species includes the lowest chromosome number known for the genus ($n = 6$). It and the following one were the subject of an intensive study by me (Smith, 1974a) in which *C nuecensoides* was found to be a new species; figures of the morphology and ranges of the two species, as well as biosystematic data, are presented in that paper. *Coreopsis nuecensis* occasionally appears as a waif or escape from cultivation in eastern regions, such as in Tangipahoa Parish, Louisiana (*R. Wilson 35,* FSU). It is endemic to Texas.

Coreopsis nuecensis is dibasic in chromosome number, some individuals being $n = 6$ and some $n = 7$. Some individuals of the $n = 7$ group carry B chromosomes and superficially appear to be $n = 8$. There is no apparent difference in morphology or range between the two basic chromosome classes, and they often occur intermixed in the same population. Hybrids between the $n = 6$ and $n = 7$ classes exhibit $n = 5^{II}, 1^{III}$ at diakinesis in meiosis and are highly fertile.

4. C. NUECENSOIDES E. B. Smith, Brittonia 26:169. 1974.

TYPE: United States: Texas: Lavaca Co., light sandy soil ca. 2 mi. E. of Hallettsville on Hwy. 90A, *J. L. Strother 174b,* 18 May 1965 (HOLOTYPE SMU!; ISOTYPE TEX!).

Blooming: Mar-May(Nov). Habitat: Sandy ditches and fields. Chromosome number: $n = 9, 10$. Fig. 5, 6.

This species was described and figures of the morphology and range were presented in an earlier paper (Smith, 1974a). It is dibasic in chromosome number, some individuals being $n = 9$ and some $n = 10$. The two chromosome classes often occur intermixed in the same population, and while there is no apparent morphological difference in the two classes, the F_1 hybrid between them exhibits a moderately reduced fertility.

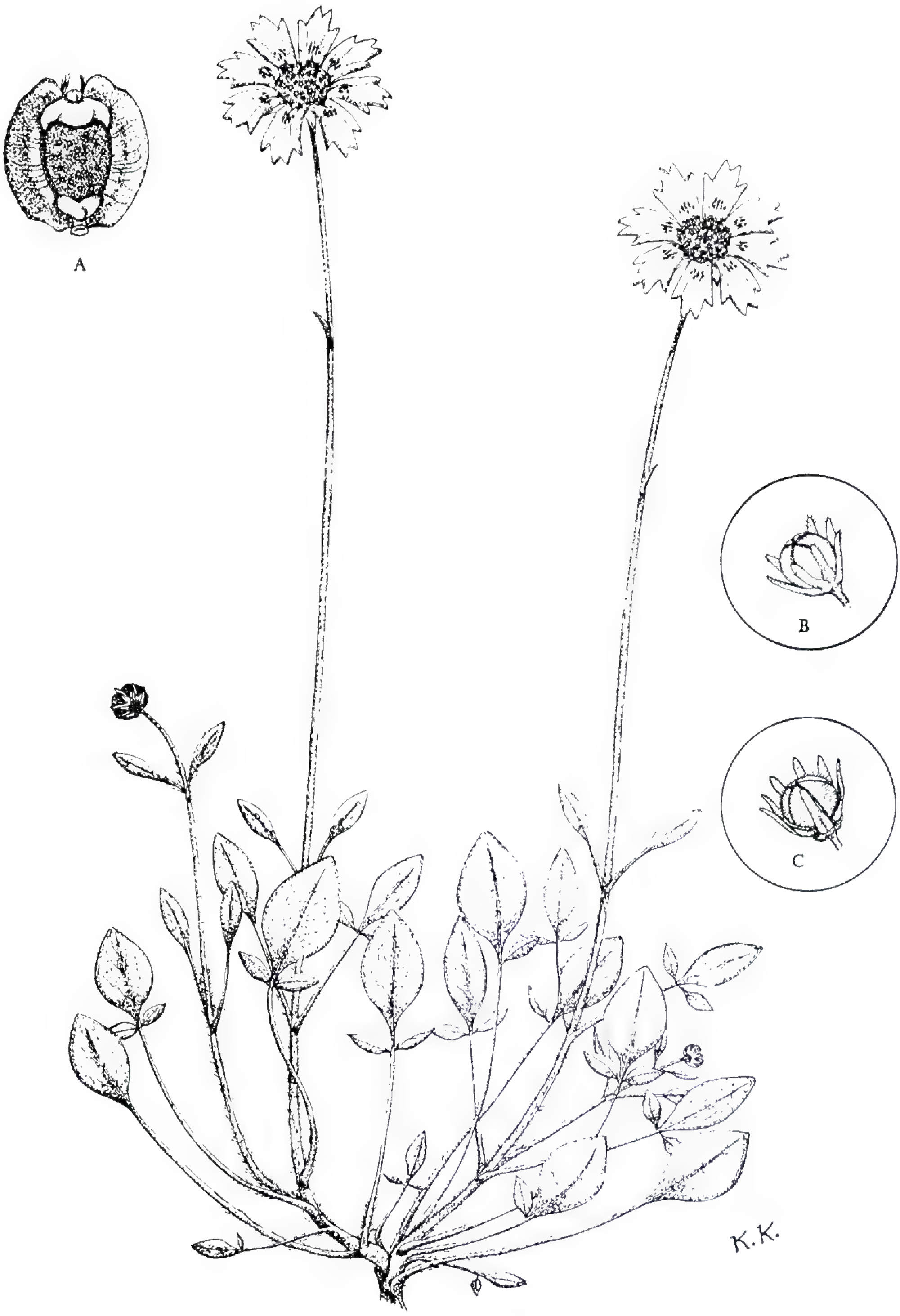


Fig. 5. *Coreopsis nuecensoides* with achene (A) and insets of a bud of *C. nuecensoides* (B), and a bud of *C. nuecensis* (C).

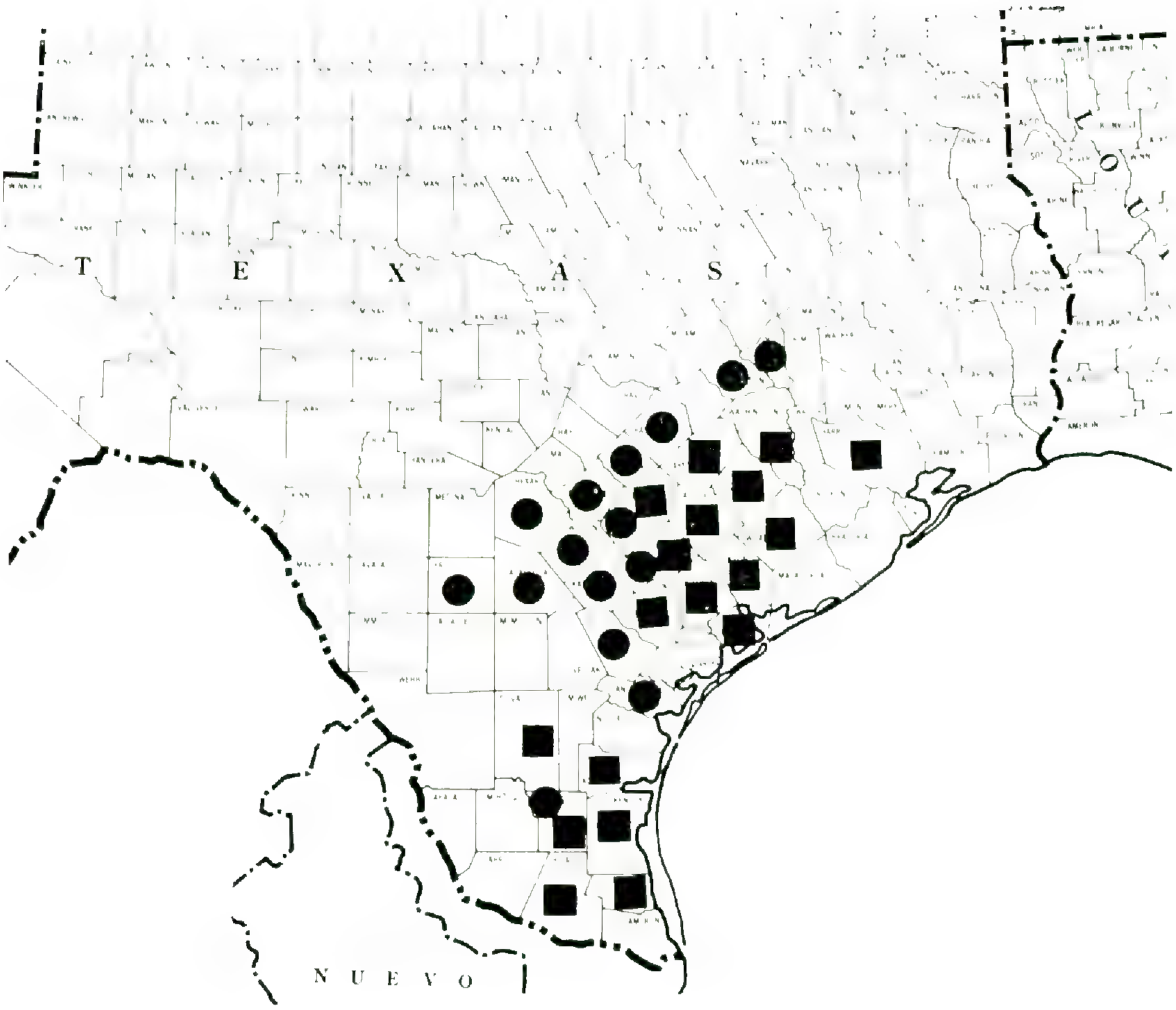


Fig. 6. Distribution of *Coreopsis nuecensis* (circles) and *C. nuecensoides* (squares). *Coreopsis nuecensoides* may occur, also, in northern Mexico (Tamaulipas).

5. C. AURICULATA L., Sp. Pl. 908. 1753.

Chrysanthemum hirsutum Plukenet, Phytographia f. 4, *pl.* 242. 1769.

Anacis auriculata Schrank, Denkschr. Königl. Akad. Wiss. München 5 (Math. Naturw.):7. 1817.

Leachia trifoliata Cass., Dict. Sci. Nat. 25:389 (as to syn. *C. auriculata* L.). 1822.

Chrysomelea auriculata Tausch, Hort. Canal. (15). 1823.

Coreopsis auriculata var. *diversifolia* Ell., Bot. S.C. & Ga. 2:437. 1823.

Coreopsis auriculata var. *glabrata* DC., Prodr. 5:571. 1836.

Coreopsis diversifolia DC., Prodr. 5:571. 1836. (not *C. diversifolia* Jacq. nor *C. diversifolia* Hook.)

Coreopsis auriculata var. β T. & G., Fl. N. Amer. 2:343. 1842.

TYPE: United States: Virginia: *John Clayton*; Herb. Gronovii (LECTOTYPE: *D. Clayton* Num. 290. BM!).

Fig. 7. *Coreopsis auriculata*; achene at upper left.

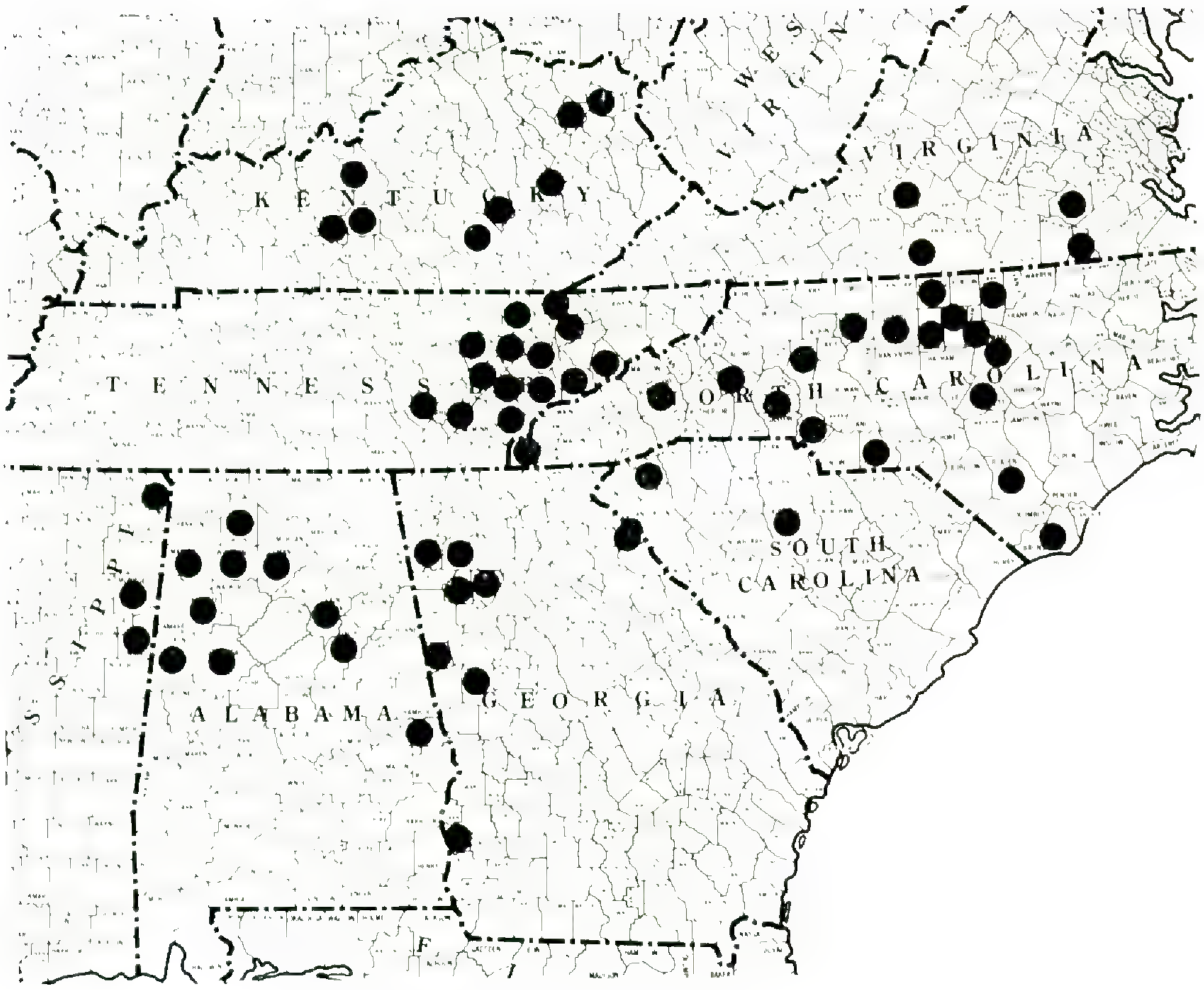


Fig. 8. Distribution of C. *auriculata*.

Blooming: Apr-May. Habitat: Wooded slopes near creeks or rivers, sandy hills. Chromosome number: $n = 13$.

A species (Fig. 7; Fig. 8) rather similar to *C. lanceolata* but generally easily distinguished from that species by its few cauline nodes, vigorous basal offshoots, outer phyllary shape, and the incurved wing of its achenes. Attempted hybridizations of *C. auriculata* with *C. grandiflora* (var. *grandiflora,* var. *saxicola,* and var. *harveyana* "heterolepis" phase), *C. nuecensis, C. nuecensoides, C. basalis, C. wrightii,* and *C.* ×*delphinifolia* all failed. In some of these crosses, normal-appearing but empty achenes were formed, suggesting that the hybridization succeeded but the hybrid embryo died at some early stage of development. Successful hybridization of *C. auriculata* with *C. lanceolata* was accomplished; see the latter species for details.

6. C. LANCEOLATA L., Sp. Pl. 908. 1753.

Coreopsis crassifolia Ait., Hort. Kew. 3:253. 1789. (not *C. crassifolia* Sesse & Moc.).

Coreopsoides lanceolata Moench, Meth. 594. 1794.

Coreopsis lanceolata var. *glabella* Michx., Fl. Bor.-Am. 2:137. 1803.

Coreopsis lanceolata var. *villosa* Michx., Fl. Bor.-Am. 2:137. 1803.

Type: United States: "Carolina" (Isotype P!).

Leachia lanceolata Tausch, Hort. Canal. (15). 1823.
Coreopsis oblongifolia Nutt., J. Acad. Nat. Sci. Philadelphia 7:76. 1834.
Coreopsis lanceolata var. *succisaefolia* DC., Prod. 5:570. 1836.
Coreopsis lanceolata var. *crassifolia* Ait.; Heyn., Nom. 1:219. 1840.
Coreopsis lanceolata var. *angustifolia* T. & G., Fl. N. Amer. 2:344. 1842.
Coreopsis heterogyna Fern., Rhodora 40:475. 1938.

TYPE: None cited. I am here designating Martyn's description and plate of *Bidens caroliniana* as the neotype (Martyn, Hist. Pl. Rar. 26 and plate. 1728. NEOTYPE !).

Blooming: Apr-May south to Jun-Jul north. Habitat: Prairies, glades, sandy slopes, and roadsides. Chromosome number: $n = 13$ (+ 0-2 B).

This species (Fig. 9; Fig. 10) exhibits considerable variability. Several intergrading phases have been recognized by previous authors at the variety or species level. The most common variation encountered in the field is the presence of a subglabrous and a pubescent phase often intermixed in the same population. Most modern treatments have recognized the pubescent phase as var. *villosa* Michx. I selected arbitrarily 70 herbarium specimens of *C. lanceolata* collected from Louisiana to northern Illinois and counted the number of hairs in a 6 mm circle from the middle of the basal leaves and median leaves. The pubescence of the first cauline internode (at least 1 cm long) was subjectively determined as densely hairy, medium hairy, or sparsely hairy to glabrous. Figure 11 presents the results of the study. It is clear that there is little correlation between pubescence of the lower leaves, median leaves, or stem of *C. lanceolata*. Individuals may have glabrous stems, hairy basal leaves, and glabrous upper leaves; or glabrous stems, glabrous basal leaves, and hairy upper leaves, etc. The "variety" *villosa* grades insensibly into the typical variety and is unworthy of recognition.

In addition to the "var. villosa" phase, several other phases are worthy of mention:

(a) Typical phase. Most individuals have a mixture of entire leaves and leaves with two auricles, the basal leaves commonly being entire or two-auricled and the median leaves two-auricled.

(b) Entire-leaved phase. Some individuals have all of the leaves entire. This phase tends to be more frequent in the northern part of the range (Ontario, Michigan, Wisconsin, Indiana, Illinois) but is intermixed with the typical phase in that region.

(c) Robust phase. Scattered through the range are individuals of unusually large size, commonly with five or six stem nodes and entire to 4(+)-auricled leaves. An entire-leaved specimen of this phase was apparently the basis for Fernald's *C. heterogyna* (Fernald, 1938); I agree completely with him that it was bold of him to propose the species. This phase may represent material of *C. lanceolata* that has been contaminated by hybridization with *C. grandiflora*.

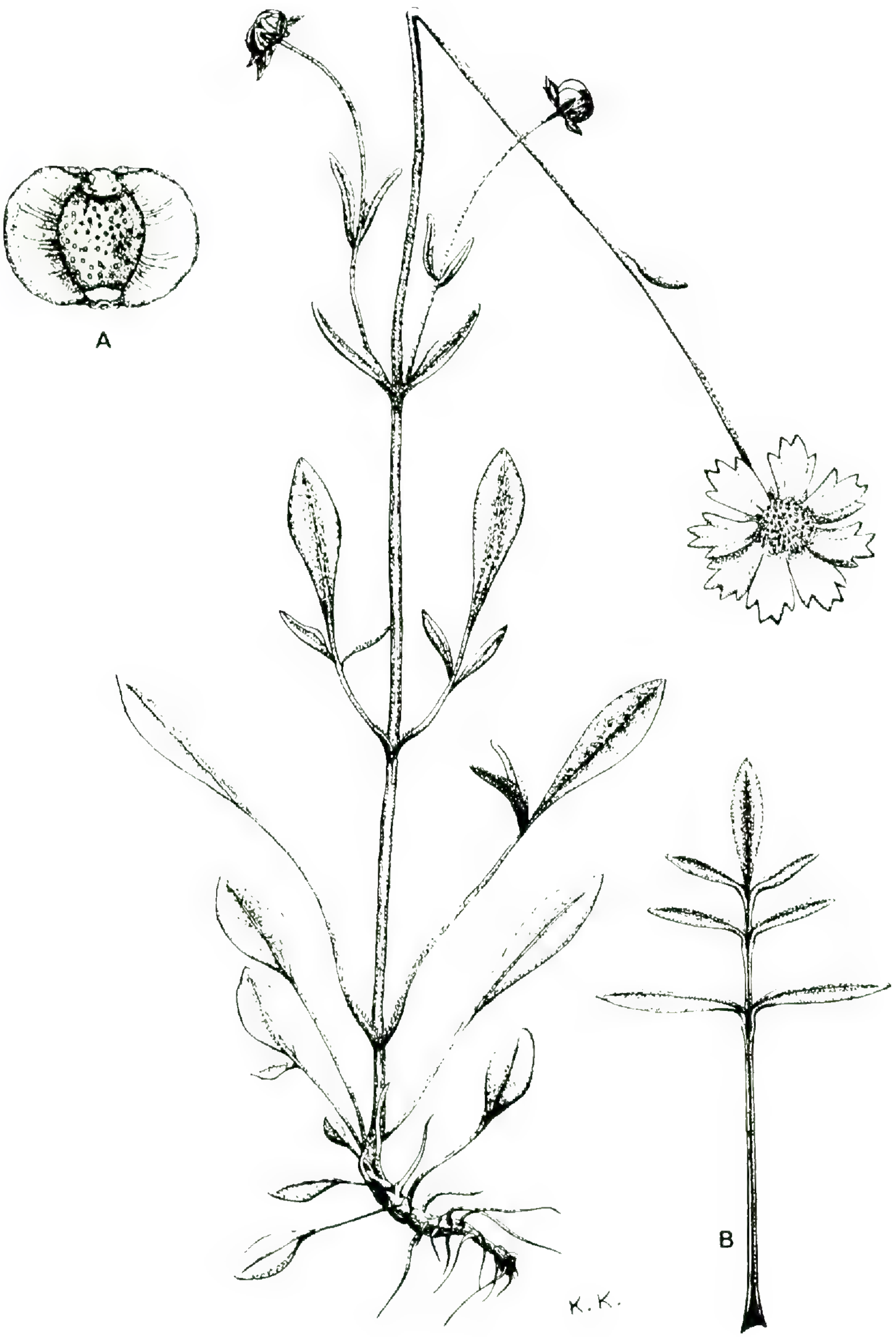


Fig. 9. *Coreopsis lanceolata*; A = achene, B = several-auricled (pinnate) leaf appearing on some individuals.

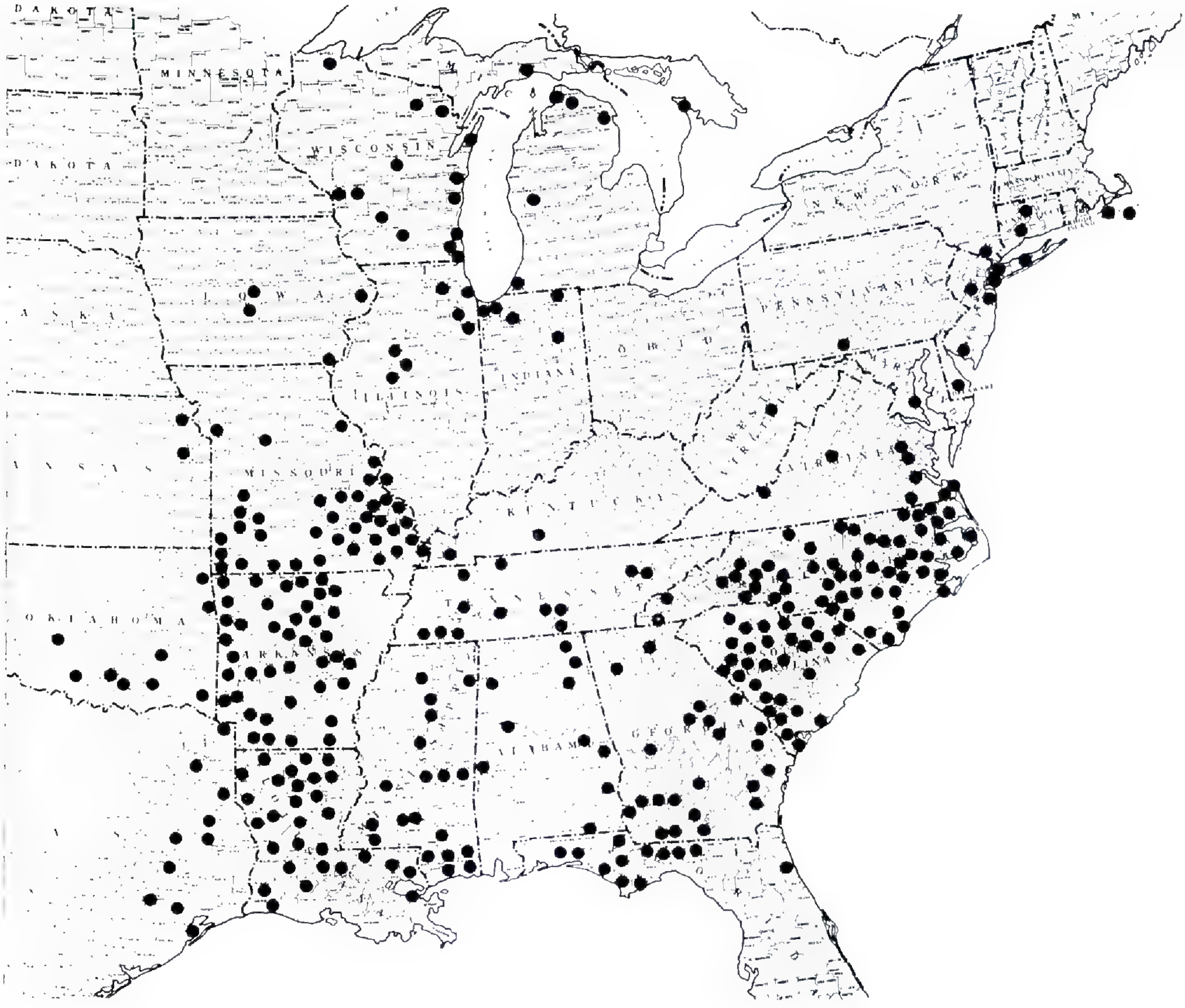


Fig. 10. Distribution of *C. lanceolata*; also known from widely scattered localities (as an escape or waif?) further west, such as San Joaquin and Ventura counties in California, Larimer Co. in Colorado, and Culberson Co. in Texas. A somewhat peculiar dwarf form, with median leaves pinnately 5-lobed occurs in New Mexico (*E. R. Vasey*, Aug. 1881, NY).

(d) Dwarf hairy phase. On dry sandy roadsides of some southern states (Florida, Georgia, South Carolina, Louisiana) occurs a dwarf phase ca 2-3 dm tall with only two or three stem nodes and densely hairy spatulate leaves. This phase was the basis for *C. crassifolia* Ait. but overlaps the typical phase in all characters. Glabrous forms of the phase occur in the same areas; the typical phase is sometimes densely hairy and varies to as short as 2 dm with two stem nodes; it sometimes has spatulate leaves.

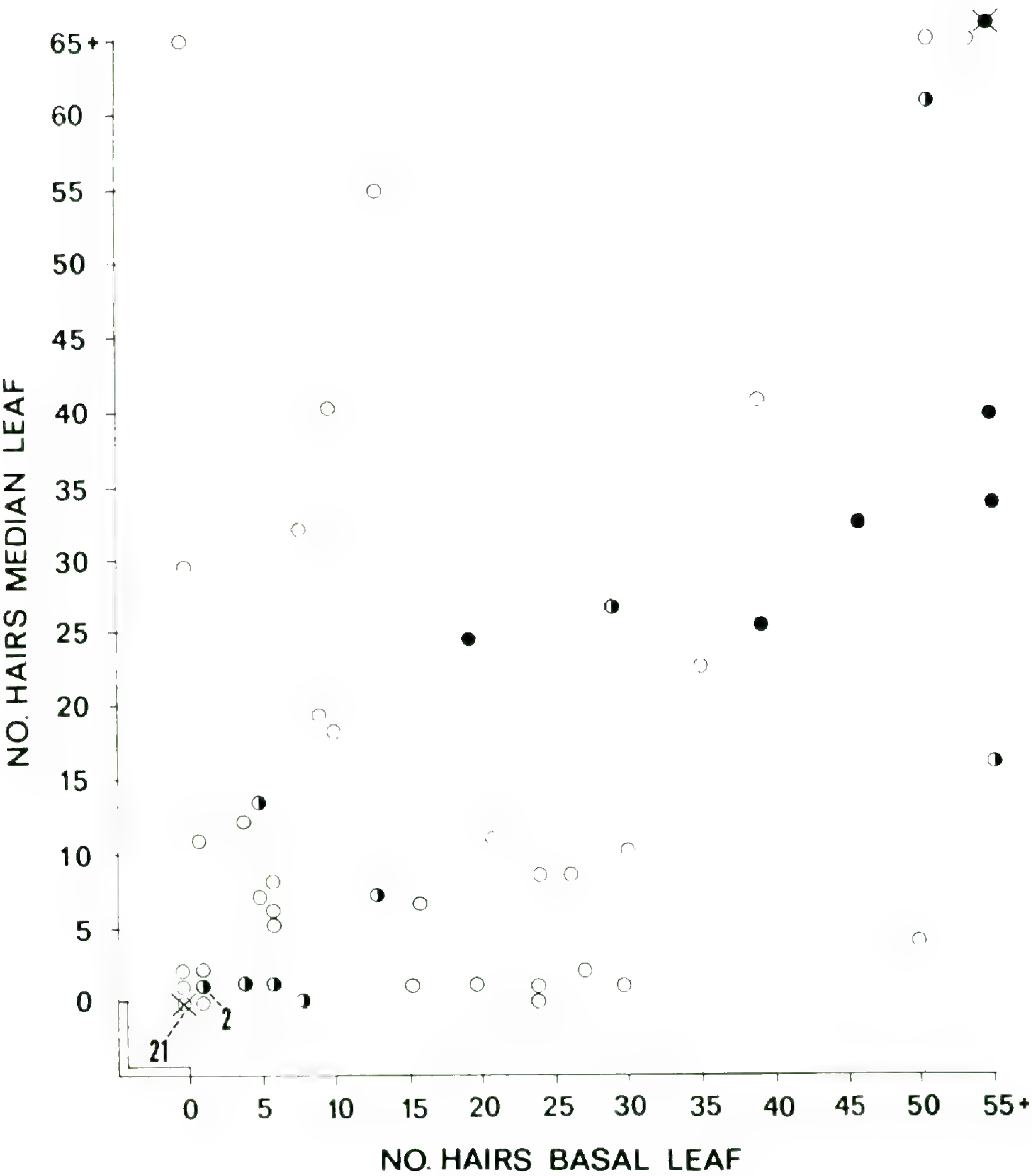


Fig. 11. Pubescence of leaves and stem in *C. lanceolata*. Open circles = sparsely hairy to glabrous stem; half-closed circles = medium-hairy stem; closed circles = densely hairy stem. The open circle with the × at lower left = ideal "var. lanceolata"; the closed circle with the × at upper right = ideal "var. villosa". Further explanation in text.

All of the phases intergrade such that it does not appear useful to segregate any of them from the typical phase.

Attempted hybridizations between *C. lanceolata* and *C. intermedia, C. nuecensoides, C. basalis, C. rosea, C. gladiata, C. tinctoria* var. *tinctoria,*

and *C. palmata* all failed. Large but empty achenes, or selfed progeny, were produced in some of the crosses.

Hybridizations that succeeded included:

C. lanceolata × *C. auriculata*. Only two F_1 hybrids were obtained. They averaged 59% pollen stainability and resembled *C. auriculata* but bore achenes with *both* an incurved cartilaginous margin and a spreading wing. No F_2 was obtained, but two BC_1 plants (*C. lanceolata* the repeating parent) averaged 57% pollen stainability.

C. lanceolata × *C. grandiflora* var. *grandiflora* f. *grandiflora*. Eighteen F_1 hybrids were obtained. Thus far 17 have bloomed; these averaged 61% pollen stainability. They had few cauline nodes (3-6) and unusually large heads (first head in bloom 5.0-7.7 cm wide). No F_2 has been produced so far.

C. lanceolata × *C. grandiflora* var. *harveyana* f. *harveyana*. Eleven F_1 hybrids were obtained. Thus far ten have bloomed; these averaged 87% pollen stainability and would have passed morphologically for *C. grandiflora* var. *grandiflora* (or rather broad-leaved var. *harveyana*). The high fertility of these hybrids suggests that *C. lanceolata* and *C. grandiflora* could hybridize and intergrade in the field, and this may be the origin of the Robust phase. No F_2 has been produced so far.

C. lanceolata × *C. grandiflora* var. *harveyana* "heterolepis" phase. Thirteen F_1 hybrids were obtained; these averaged 11% pollen stainability and would have passed morphologically for *C. grandiflora* var. *harveyana*. The large difference in pollen stainability between this cross and the previous one was unexpected, since the "heterolepis" phase cannot be separated satisfactorily from var. *harveyana* on morphological grounds. There is a suggestion here that *C. lanceolata* or *C. grandiflora* (or both) may contain unrecognized diversity in chromosome structure, which would not be surprising in species of such wide geographic range. A few F_2 achenes of this cross have been obtained but not yet grown.

C. lanceolata × *C. grandiflora* var. *saxicola*. Achenes of this cross have been obtained but not yet grown.

C. lanceolata × *C. pubescens* var. *pubescens*. Five F_1 hybrids were obtained. Three have bloomed so far; these averaged 20% pollen stainability.

7. C. INTERMEDIA Sherff, Bot. Gaz 88:299. 1929.

TYPE: United States: Texas: Wood Co., Sandy woods, Mineola. *J. Reverchon 2077*, 12 Jun 1900 (HOLOTYPE B, destroyed; ISOTYPE MO).

Blooming: late May-early Jul(Aug). Habitat: Sandy woods. Chromosome number: $n = 13$ (+ 0-1 B).

I have not seen type material of this species but have examined material of the same collection number (*J. Reverchon 2077*) from NY. This is a rare species (Fig. 12) previously known only from the type locality and vicinity (Sherff, 1955). I have observed material from several other localities (Fig. 13), including two collections from northwestern Louisiana (*Thieret 31204, Smith 1834*; UARK). The species varies from nearly glabrous to rather

Fig. 12. *Coreopsis intermedia*; A = achene with entire wing, B = achene with irregularly fimbriate wing.

densely short pubescent; the achene wings vary from entire to irregularly partially fimbrate.

Attempted hybridization of *C. intermedia* with *C. grandiflora* var. *harveyana* (both the normal and the "heterolepis" phase), *C. basalis*, *C. wrightii*, *C auriculata*, *C. lanceolata*, *C. rosea*, *C. linifolia* (diploid race), *C. nudata*, *C. gladiata*, *C. tinctoria* var. *tinctoria*, *C. major* f. *major*, *C. major* f. *oemleri* (hexaploid race), *C. tripteris* and *C. latifolia* all failed.

Successful hybridization included:

C. intermedia × *C. grandiflora* var. *grandiflora*. Mature achenes were obtained but have not yet been grown.

C. intermedia × *C. grandiflora* var. *saxicola*. Thirteen F_1 hybrids were obtained; these averaged 66% pollen stainability. One analyzed meiotically

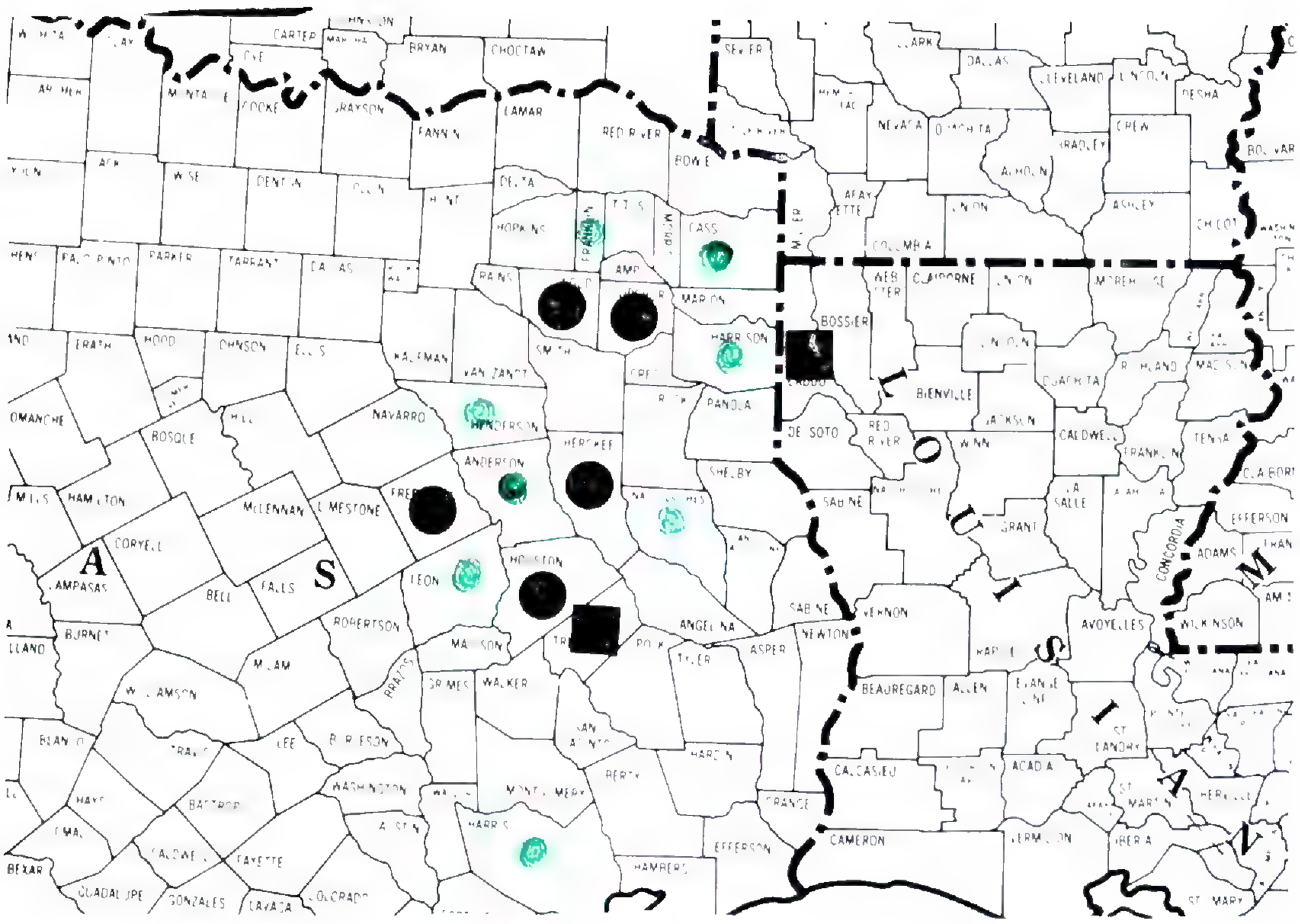


Fig. 13. Distribution of *C. intermedia*; dots = semi-glabrous phase, squares = pubescent phase.

exhibited $n = 13$ at diakinesis and regular distribution (13:13) at anaphase I. Thirty-three F_2 hybrids of this cross were grown. Thus far, 27 have flowered; these 27 averaged 52% pollen stainability. Some individuals produced very little pollen.

C. intermedia × *C. pubescens* var. *debilis*. Eleven F_1 hybrids were obtained; these averaged 39% pollen stainability. A few F_2 achenes have been obtained but not yet grown.

C. intermedia × *C. pubescens* var. *pubescens*. Sixteen F_1 hybrids were obtained; 14 of these averaged 49% pollen stainability. In a reciprocal cross, four F_1 hybrids averaged 43% pollen stainability. The *C. pubescens* parent in this cross had a pair of B chromosomes ($n = 13^{II} + 1^{II\ B}$). Three F_1 hybrids analyzed meiotically had $n = 10^{II}, 1^{III}, 1^{IV}$ and $n = 11^{II}, 1^{IV}, 1^{I}$ at diakinesis, suggesting that *C. intermedia* and *C. pubescens* var. *pubescens* differ chromosomally by one reciprocal translocation and that the B chromosome sometimes pairs with another of the normal pairs of chromosomes (i.e., is at least partly trisomic). Eighteen F_2 hybrids of this cross were obtained; only ten have bloomed. These ten averaged 19% pollen stainability; several produced very little pollen. Eight BC_1 hybrids (*C. pubescens* var. *pubescens* the repeating parent) were obtained; six of these averaged 59% pollen stainability.

C. intermedia × *nuecensis*. Four F_1 hybrids of this cross were obtained; three of these averaged 0.5% pollen stainability. One analyzed at diakinesis of meiosis had $n = 1^{I}, 2^{II}, 1^{IV}, 1^{V}$. The heads produced by the F_1 hybrids had pubescent inner phyllaries and ligules with darker yellow bases, with some ligules basally flecked and some non-flecked.

It is clear from the above hybridization data that *C. intermedia* is closely allied with *C. grandiflora* and *C. pubescens*.

8a. C. PUBESCENS Ell., Bot. S. C. & Ga. 2:44. 1823, var. PUBESCENS

Coreopsis auriculata sensu Schkuhr, Handb. 3:156. 1803. (not *C. auriculata* L.)

Coreopsis auriculata T. & G. vars. γ and δ, Fl. N. Amer. 2:343-344. 1842.

Coreopsis pubescens var. *typica* Sherff, Brittonia 6:341. 1948.

TYPE: None cited; habitat given as "western districts of Georgia". I am here designating a neotype: NEOTYPE: United States: Arkansas: Carroll Co., common along fencerow by hwy. 68, 13.3 mi. ENE of the Carroll-Madison co line, *E. B. Smith 1759*, 25 Jul 1973 (US!). In designating a neotype for this species, I am deliberately avoiding selection of a specimen from the "western districts of Georgia," since this area is near the edge of the range of *C. pubescens* var. *pubescens* and contamination of the variety *pubescens* with *C. grandiflora* var. *saxicola* or *C. pubescens* var. *robusta* is not uncommon there. Little or no contamination of var. *pubescens* occurs in the Arkansas area.

Blooming: Jun-Aug. Habitat: Alluvial banks, open woods, sandy fields. Chromosome number: $n = 13$ (+ 0-2 B).

A species (Fig. 14, A-D; Fig. 15, dots) resembling *C. auriculata* but differing in its much larger size with many stem nodes, narrow outer phyllaries, and winged achenes.

Attempted hybridizations of *C. pubescens* var. *pubescens* with *C. nuecensoides*, *C. basalis*, *C. palmata*, and *C. tripteris* all failed.

Successful hybridizations included:

C. pubescens var. *pubescens* × *C. auriculata*. Only three F_1 hybrids were obtained; only one has bloomed and it had 10% pollen stainability.

C. pubescens var. *pubescens* × *C. intermedia*. Four F_1 hybrids are mentioned under the latter species.

C. pubescens var. *pubescens* × *C. grandiflora* var. *saxicola*. Four F_1 hybrids of this cross averaged 27% pollen stainability. The hybrids looked much like *C. grandiflora* var. *grandiflora* f. *pilosa*. Nine BC_1 hybrids (*C. pubescens* var. *pubescens* the repeating parent) were obtained; eight of these averaged 62% pollen stainability. Three reciprocal BC_1 hybrids (*C. grandiflora* var. *saxicola* the repeating parent) were obtained; they averaged 55% pollen stainability.

The parent material of both var. *pubescens* and var. *saxicola* in the above crosses was from Arkansas. In one reciprocal cross, *C. grandiflora* var. *saxicola* × *C. pubescens* var. *pubescens*, where the var. *saxicola* parent

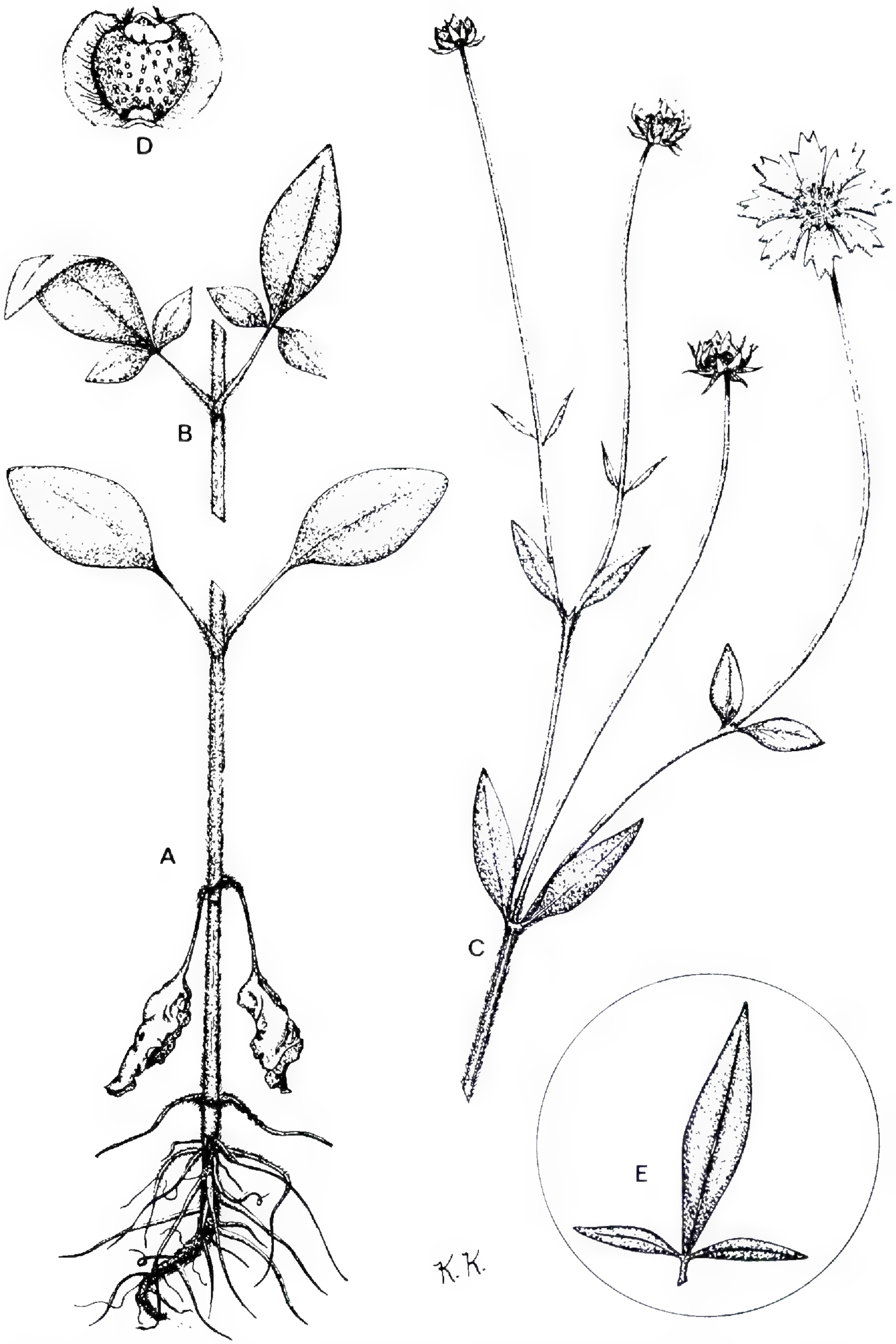


Fig. 14. *Coreopsis pubescens* var. *pubescens* (A-D) and var. *robusta* (E).
A = lower stem; B = median stem; C = upper stem and flowers;
D = achene; E = median leaf of var. *robusta*.

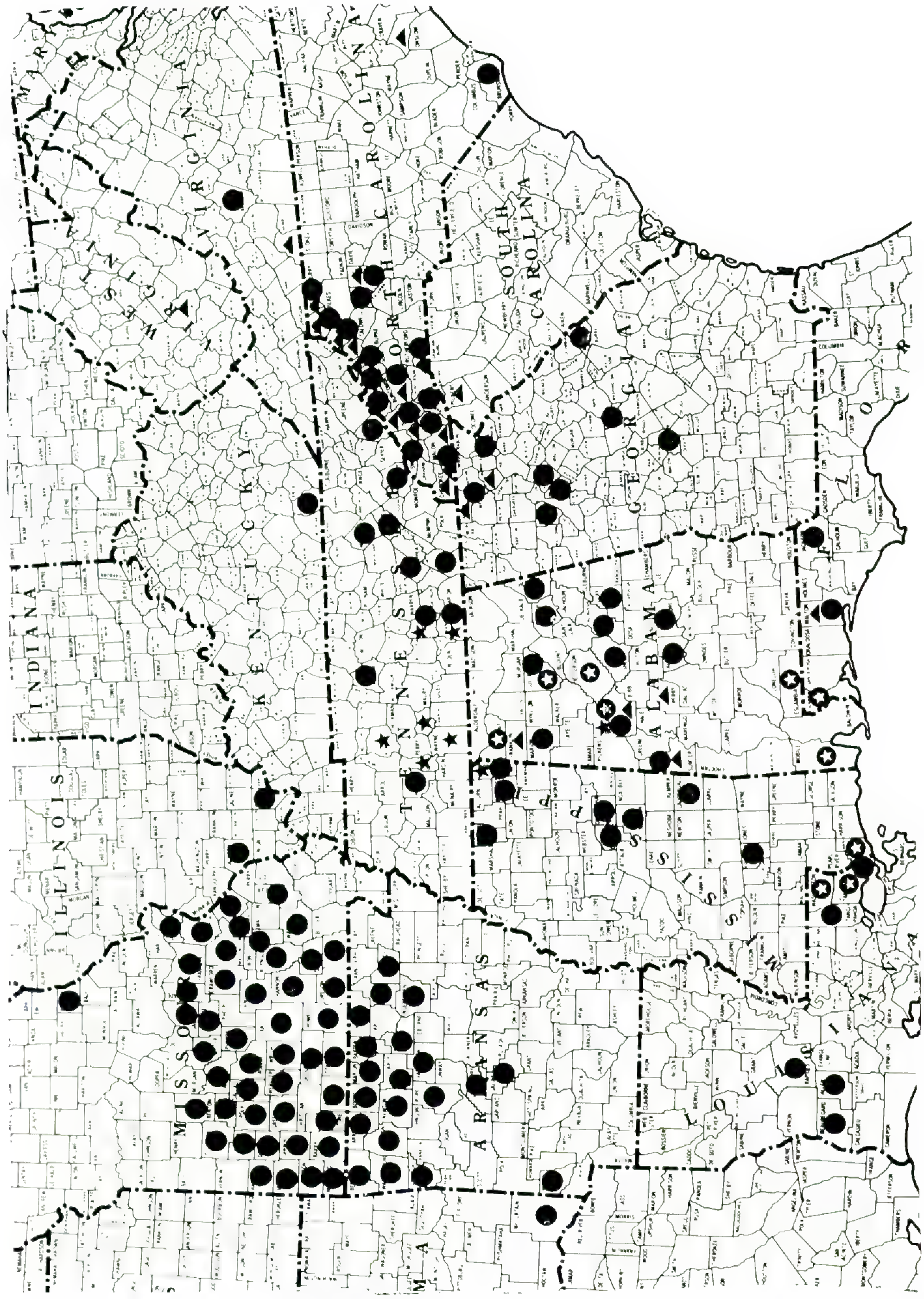


Fig. 15. Distribution of *C. pubescens*. Dots = var. *pubescens*; triangles = var. *robusta*; white star in black circle = var. *debilis*, sparsely hairy to essentially glabrous; black stars = var. *debilis*, apparently intergrading with var. *pubescens* and definitely hairy.

material was from Georgia, eight F_1 hybrids averaged 3% pollen stainability, suggesting that the var. *saxicola* material from Georgia differs chromosomally from the Arkansas material of var. *saxicola*.

C. pubescens var. *pubescens* × *C. pubescens* var. *debilis*. Thirteen F_1 hybrids of this cross were obtained; they averaged 90% pollen stainability, indicating very close relationship between these two varieties. All F_1 plants were pubescent. Twenty-four F_2 hybrids were obtained; 21 of these averaged 60% pollen stainability, with a range from 0 to 98%. Twenty-one of the 24 F_2 were pubescent and three were essentially glabrous. Ten BC_1 hybrids (var. *debilis* the repeating parent) were obtained; these averaged 91% pollen stainability. Eight of the ten were pubescent and two were essentially glabrous. The glabrous plants approached the morphology of *C. pubescens* var. *robusta*.

C. pubescens var. *pubescens* × *C. lanceolata*. Five F_1 hybrids are mentioned under the latter species.

8b. C. PUBESCENS Ell. var. ROBUSTA A. Gray ex Eames, Rhodora 18:239. 1916.

Coreopsis testudinea Shuttl., *nom. nud., in* Sherff, Field Mus. Publ. Bot. 11:351. 1936.

TYPE: United States: North Carolina: North Branch of New River, *A. Gray* and *J. Carey s.n.*, Jul 1841 (HOLOTYPE GH!).

Blooming: Jun-Aug. Habitat: Wooded slopes, glades, meadows, edge of cliffs. Chromosome number: unknown.

I collected only a few living plants of var. *robusta* (Fig. 14, E; Fig. 15, triangles), and all of these died in the greenhouse prior to my being able to determine their chromosome number or use them in attempted hybridizations. The var. *robusta* intergrades somewhat with var. *pubescens* in the mountainous districts of western North Carolina and northeastern Georgia but can usually be distinguished with little difficulty. I believe it should be retained at the varietal level.

8c. C PUBESCENS Ell. var. **debilis** (Sherff) E. B. Smith, comb. & stat. nov.

Coreopsis debilis Sherff, Bot. Gaz. 89:366. 1930.

Coreopsis corninsularis Sherff, Bot. Gaz. 94:597. 1933. Type: United States: Mississippi: Horn Island, *S. M. Tracy 8542*, 25 May 1903 (HOLOTYPE MO!; ISOTYPE F!).

TYPE: United States: Mississippi: Harrison Co., In dry, sandy, old fields along coast of Mississippi Sound, *J. D. Smith 602*, 15 Sept. 1885 (HOLOTYPE F!; ISOTYPE US!, 2 sheets).

Blooming: late May-Aug(Sep). Habitat: Old sandy fields, rocky outcrops, slopes. Chromosome number: $n = 13$.

Coreopsis debilis is a peculiar segregant of *C. pubescens*, as indicated by its interfertility with *C. pubescens* var. *pubescens* (see hybridizations under var. *pubescens*) and its intergradation with var. *pubescens* in the

northern Alabama-Mississippi-central Tennessee area. The extreme coastal form (Fig. 16; Fig. 15, white star on black circle) with its bushy habit, glabrous stem and blades, and two-auricled or weakly pinnate leaves appears like an unusual form of *C. grandiflora*. Some individuals with entire to two-auricled leaves tend to mimic glabrous *C. lanceolata*; in the area of intergradation with var. *pubescens*, pubescent individuals appear (Fig. 15, stars) that seem to be rather peculiar material of *C. lanceolata* "var. villosa" (a variety which is itself merely a populational segregant). Generally, it can be distinguished by its bushy habit, small heads, and intermediate number of cauline nodes. I believe it should be recognized at the varietal level.

The rare "species" *C. corninsularis* Sherff (known only from Horn Island, Mississippi; Sherff, 1955) is scarcely different from the subentire-leaved forms of *C. debilis*. I have been unable to obtain living material of *C. corninsularis* but am convinced that it would be freely interfertile with *C. debilis* and should therefore be merged with it as *C. pubescens* var. *debilis*.

Attempted hybridization of *C. pubescens* var. *debilis* with *C. tinctoria* var. *tinctoria* failed.

Coreopsis pubescens var. *debilis* is highly interfertile with *C. pubescens* var. *pubescens* (see above) and shows low to intermediate interfertility with *C. intermedia*, *C. grandiflora* var. *harveyana*, and *C. lanceolata*. See the latter three species for details.

9a. C. GRANDIFLORA Hogg ex Sweet, Brit. Fl. Gard. 2: *pl.* 175. 1826, var. GRANDIFLORA forma GRANDIFLORA

Coreopsis boykiniana Nutt., Trans. Amer. Philos. Soc. II. 7:358. 1841.

Coreopsis heterophylla Nutt., ibid. (not *C. heterophylla* of others).

Coreopsis grandiflora var. *subintegrifolia* T. & G., Fl. N. Amer. 2: 345. 1842.

TYPE: United States: Sent by a Mr. Hogg from New York to England; represented by Robert Sweet's Type Plate (loc. cit.)! Sherff (1936) specified that Sweet's plate would serve as the type for *C. grandiflora*. I inquired for possible type material at BM, but none exists there.

Blooming: late May-Jun. Habitat: Roadsides, prairies, sandy glades, railroads. Chromosome number: $n = 13$ (+ 0-4 B).

Coreopsis grandiflora (Fig. 17), a complex species of wide range (Fig. 18), has several somewhat intergrading varieties and a number of forms. Its complexity probably stems from local differentiation over its wide range plus its general promiscuity as indicated in artificial hybridizations.

Attempted hybridizations of *C. grandiflora* var. *grandiflora* f. *grandiflora* with *C. grandiflora* var. *longipes*, *C. nuecensoides*, *C. basalis*, *C. rosea*, and *C. major* f. *major* all failed. But *C. grandiflora* var. *grandiflora* f. *grandiflora* exhibited medium to high interfertility with *C. grandiflora* var. *grandiflora* f. *pilosa*, *C. grandiflora* var. *harveyana* f. *harveyana*, and *C. lanceo-*

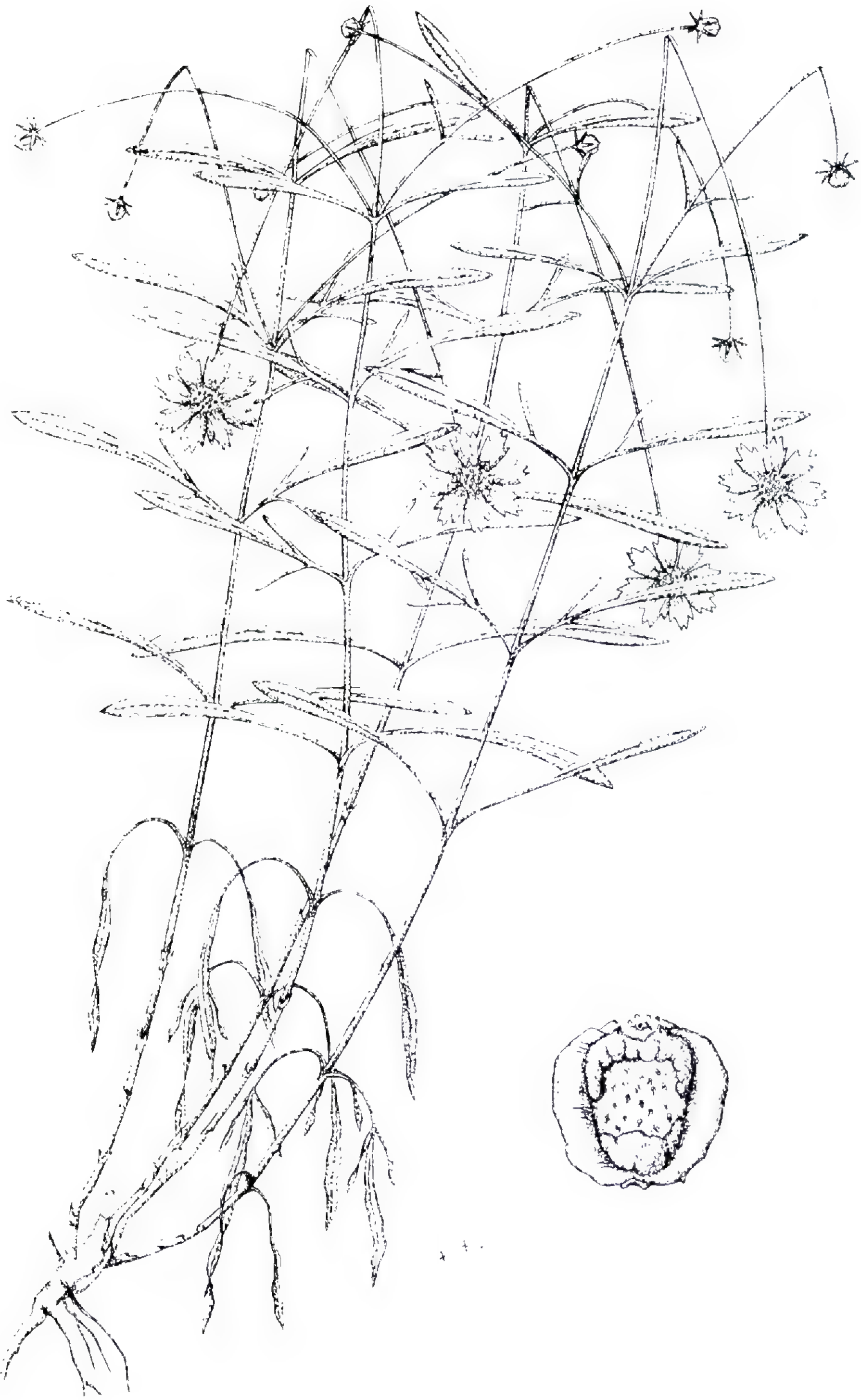


Fig. 16. *Coreopsis pubescens* var. *debilis*; achene at lower right.

lata; see these latter taxa for details.

9b. C. GRANDIFLORA Hogg *ex* Sweet var. GRANDIFLORA forma **pilosa** (Sherff) E. B. Smith, comb. & stat. nov.

Coreopsis grandiflora var. *pilosa* Sherff, Bot. Gaz. 89:368. 1930.

TYPE: Cultivated at Agricultural Station, Island of Bermuda. *S. Brown, N. L. Britton & P. Bisset 2011*, 22 May-6 Jun 1914 (HOLOTYPE NY!).

Blooming: May-Jul. Habitat: Roadsides, fields. Chromosome number: $n = 13$.

This form, treated as a variety by Sherff (1936, 1955), was recently known in the wild state only from northern Georgia (Sherff, 1955). I have seen material of f. *pilosa* from Georgia, Alabama, Mississippi, eastern Texas, and eastern Oklahoma (Fig. 18, white star on black circle). The form tends to occur at the limits of the range of *C. pubescens* var. *pubescens* and probably has arisen through the hybridization of *C. grandiflora* var. *grandiflora* (and, possibly var. *harveyana*) with that species. Artificial hybridizations between *C. pubescens* var. *pubescens* and *C. grandiflora* var. *saxicola* have produced offspring that in some cases mimic the naturally occurring f. *pilosa*. The pubescent f. *pilosa* occurs intermixed with the glabrous f. *grandiflora*.

I raised four plants in the greenhouse from achenes harvested from a f. *pilosa* plant in northern Georgia; two were glabrous and two were pubescent. I crossed one of the pubescent ones with one of the glabrous ones; of 12 offspring, five were pubescent and seven glabrous. I also crossed two of the pubescent plants; of 16 offspring, all were pubescent. These results indicate that f. *pilosa* differs from f. *grandiflora* by a single gene, with the glabrous condition dominant and the pubescent condition homozygous recessive.

9c. C. GRANDIFLORA Hogg *ex* Sweet var. SAXICOLA (Alex.) E. B. Smith, Brittonia 25:207. 1973.

Coreopsis saxicola Alex., Torreya 31:161. 1932.

Coreopsis saxicola Alex. var. *duncanii* Sherff, Bot. Leafl. 6:2. 1952. Type: United States: Georgia: Oglethorpe Co., in shallow soil at edge of thickly vegetated drain at Echol's Mill SE of Point Peter, *W. H. Duncan 3832*, 4 Aug 1941 (HOLOTYPE GA!).

TYPE: United States: Georgia: DeKalb Co., on thin soil over granite, Stone Mountain, *F. W. Pennell 4029*, 2 Aug 1912 (HOLOTYPE NY!).

Blooming: Jun (in Arkansas), Jul-Aug (in Georgia & Alabama). Habitat: Shallow sandy soil over sandstone or granite. Chromosome number: $n = 13$ (+ 0-4 B).

I have given detailed reasons elsewhere (Smith, 1973) for the reduction of *C. saxicola* to a variety of *C. grandiflora* and for the merging of var. *duncanii* with var. *saxicola*. Variety *saxicola* (Fig. 17, B; Fig. 18, open stars) is not homogeneous; the eastern phase (Georgia, Alabama) blooms later than the western phase (Arkansas), has somewhat wider leaf segments

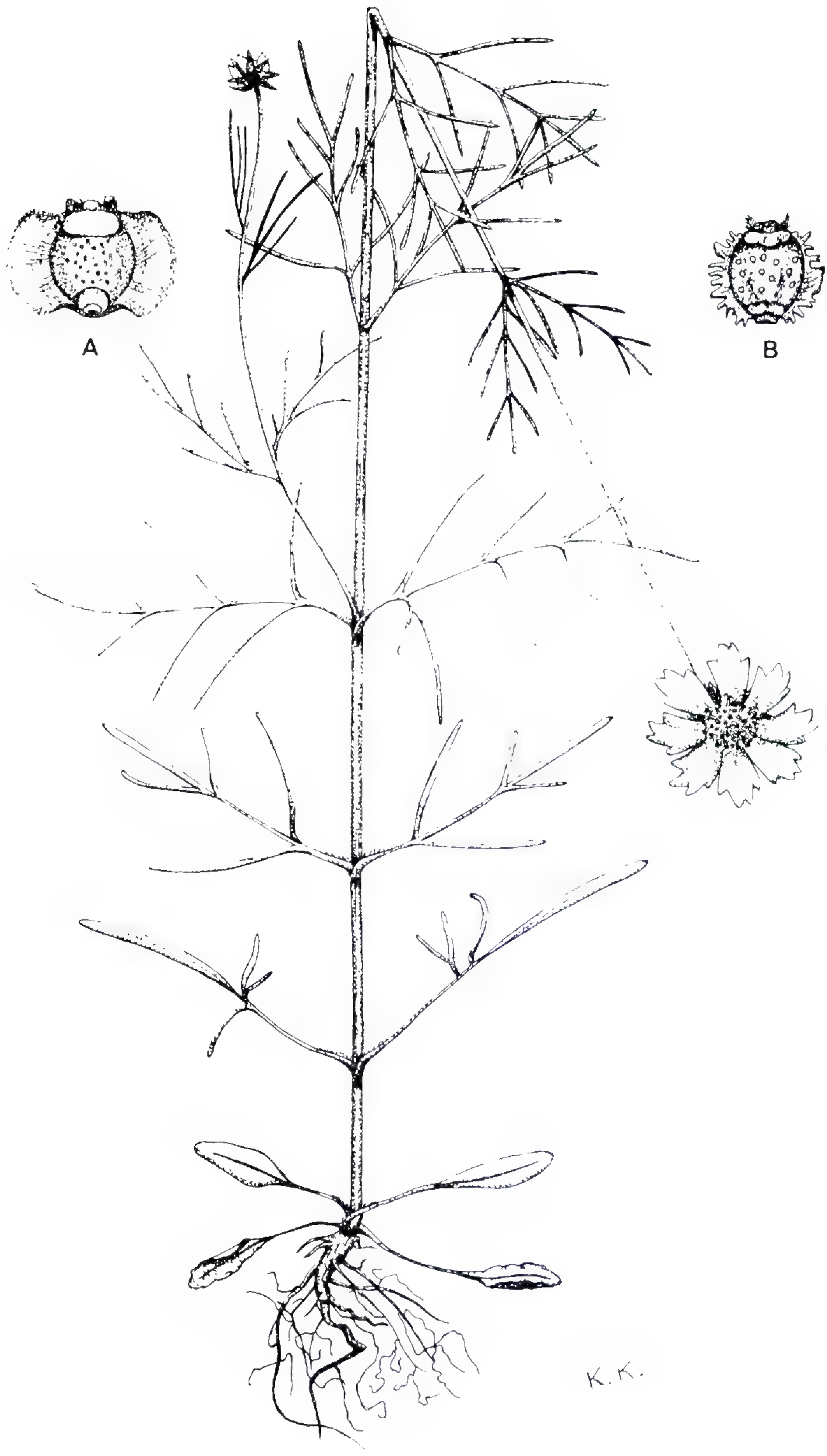


Fig. 17. *Coreopsis grandiflora* var. *harveyana* (plant and achene A) and var. *saxicola* (achene B).

than the western phase, and apparently differs somewhat chromosomally (see hybridization, below).

Attempted hybridizations of *C. grandiflora* var. *saxicola* with *C. grandiflora* var. *longipes*, *C. basalis*, *C. auriculata*, *C. nudata*, *C. major* f. *oemleri* (hexaploid race), *C. tripteris*, and *C. latifolia* all failed.

Successful hybridizations included:

C. grandiflora var. *saxicola* (Arkansas phase) × *C. grandiflora* var. *harveyana*. Six F_1 hybrids of this cross averaged 96% pollen stainability. Eighteen F_2 plants were highly fertile. In a repeat of this cross performed a year later, with the var. *harveyana* material represented by the "heterolepis" phase, five F_1 hybrids averaged 31% pollen stainability; in diakinesis of meiosis these F_1 hybrids exhibited mostly $n = 8^{II}, 1^{IV}, 1^{VI}$, indicating at least four structural differences in the parental chromosome complements.

C. grandiflora var. *saxicola* (western phase; $n = 13 + 2$ B) × *C. grandiflora* var. *saxicola* (eastern phase; $n = 13$). Twelve F_1 hybrids of this combination were raised and these averaged 37% pollen stainability; at diakinesis one of these exhibited $n = 13 + 1$ B. The eastern and western phases of var. *saxicola* appear to differ somewhat, but the lowered F_1 fertility is evidently not due to major structural differences in the chromosome complements of the two.

Several crosses were made with respect to inheritance of the B chromosomes commonly present in Arkansas material of var. *saxicola*. The crosses made and the results were:

$n = 13 + 2$ B × $n = 13$. Eighteen F_1 hybrids of this cross were obtained. Chromosome counts were obtained for 15 plants. Two were $n = 13$ and averaged 95% pollen stainability; 13 were $n = 13 + 1$ B and 12 of these averaged 89% pollen stainability.

$n = 13 + 3$ B × $n = 13$. Seventeen F_1 hybrids of this cross were obtained. Chromosome counts were obtained for 14 plants. Nine were $n = 13 + 1$ B and eight of these averaged 94% pollen stainability; five were $n = 13 + 2$ B and averaged 83% pollen stainability.

$n = 13$ × $n = 13 + 4$ B. Ten F_1 hybrids of this cross were obtained. Chromosome counts were obtained for nine plants. Four were $n = 13 + 2$ B and averaged 97% pollen stainability; one was $n = 13 + 3$ B and had 16% pollen stainability; and four were $n = 13 + 4$ B and averaged 23% pollen stainability.

The above crosses indicate that the B chromosomes in var. *saxicola* material from Arkansas behave normally on the maternal side but tend to increase (or at least be maintained) on the paternal side. The B chromosomes have no noticeable effect on the morphology but, as in *Haplopappus* (Smith, 1968c), reduce pollen stainability significantly when three or more are present. Several meiotic cells seen in the plants of this series of crosses were autotetraploid, the observed frequency varying in individual plants from very low to as high as 50% in one individual of $n = 13 + 4$ B con-

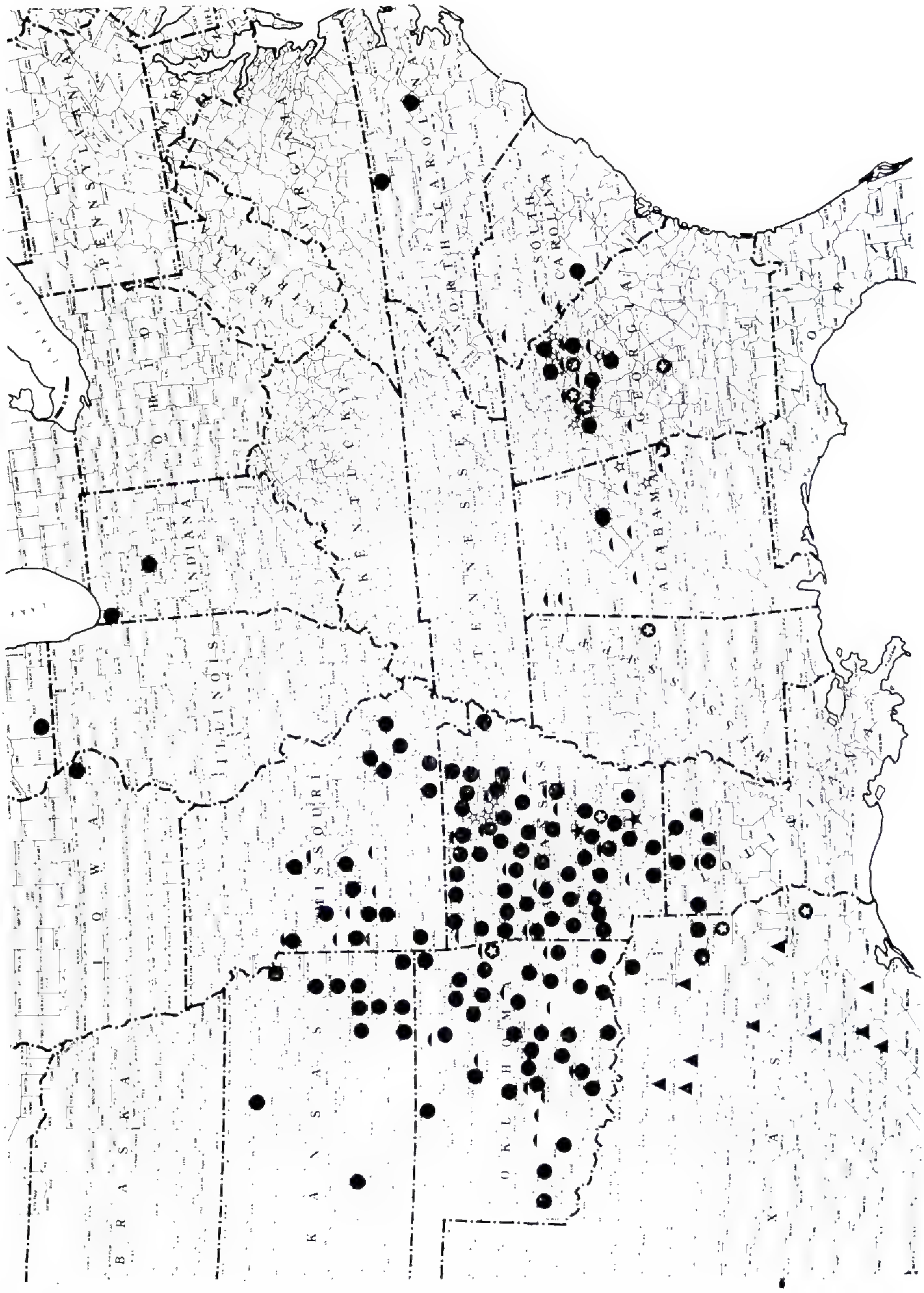


Fig. 18. Distribution of *C. grandiflora*: semicircles = *C. grandiflora* var. *grandiflora* f. *grandiflora*; white star in black circles = *C. grandiflora* var. *grandiflora* f. *pilosa*; dots = *C. grandiflora* var. *harveyana f. harveyana*; closed stars = *C. grandiflora* var. *harveyana* f. *demareei*; open stars = *C. grandiflora* var. *saxicola*; triangles = *C. grandiflora* var. *longipes*.

stitution (the autotetraploid cells at diakinesis were mostly $n = 23^{II}$, 2^{III}, 1^{IV}).

C. grandiflora var. *saxicola* (eastern phase) × *C. pubescens* var. *pubescens*. Eight F_1 hybrids of this combination averaged 3% pollen stainability and morphologically resembled *C. grandiflora* var. *grandiflora* f. *pilosa*. The reciprocal of this cross (with the western phase of var. *saxicola*), as well as BC_1 hyrids, was considerably more fertile. See *C. pubescens* var. *pubescens* hybridizations for details.

C. grandflora var. *saxicola* hybridized successfully with *C. intermedia;* see the latter species for details.

9d. C. GRANDIFLORA Hogg *ex* Sweet var. HARVEYANA (A. Gray) Sherff, Bot. Gaz. 94:593. 1933, forma HARVEYANA

Coreopsis harveyana A. Gray, Syn. Fl. N. Amer. I^2:292. 1884.

Coreopsis heterolepis Sherff, Bot. Gaz. 89:365. 1930. Type: United States: Arkansas: Cleburne Co., on dry sandy bluffs, Heber Springs, *E. J. Palmer 6962A*, 30 Oct. 1914 (HOLOTYPE MO!; ISOTYPE MO!, two sheets).

TYPE: United States: Arkansas: on cliffs near Fort Smith, *F. L. Harvey s.n.*, Jun (HOLOTYPE GH!).

Blooming: May-Jun (Sep-Oct in late season forms). Habitat: Sandy ridges, sandstone glades, rocky hillsides and prairies, roadsides, near railroad tracks. Chromosome number: $n = 13$.

This variety (Fig. 17; Fig 18, dots) is similar to var. *grandiflora* but has very narrow upper leaf segments and generally smaller heads. It reaches its greatest abundance in Arkansas. The "species" *C. heterolepis,* named by Sherff on the basis of its "densely aggregated basal leaves" and small heads, is merely a late season form of var. *harveyana* with clusters of leaves at old leaf bases (basically aerial rosettes) and with a few late heads in bloom. Several species of *Coreopsis* in this section and section *Eublepharis* commonly form such late season aerial rosettes. The "species" overlaps var. *harveyana* in all respects and cannot be maintained on any presently known morphological basis. However, there apparently are chromosomal differences between the typical var. *harveyana* and the "heterolepis" phase (see the *C. grandiflora* var. *saxicola* hybridizations and some of the crosses below). Localized chromosomal heterogeneity might be expected in a wide-ranging species such as *C. grandiflora.*

Forma *harveyana* is essentially glabrous on the stem and the flat surfaces of the blades.

Attempted hybridizations of *C. grandiflora* var. *harveyana* f. *harveyana* with *C. grandiflora* var. *longipes* and *C. tinctoria* var. *tinctoria* failed.

Successful hybridizations included:

C. grandiflora var. *harveyana* f. *harveyana* × *C. pubescens* var. *debilis*. Ten F_1 hybrids of this combination averaged 35% pollen stainability; one of these analyzed meiotically exhibited $n = 10^{II}$, 2^{III} at diakinesis.

C. grandiflora var. *harveyana* f. *harveyana* (typical phase) × *C. grandiflora* var. *harveyana* f. *harveyana* ("heterolepis" phase). Four F_1 hybrids of this cross averaged 20% stainability. At diakinesis, these exhibited $n = 9^{II}, 2^{IV}$ + a small fragment; at anaphase I, some cells showed a bridge and fragment, indicating heterozygosity for an inversion.

C. grandiflora var. *harveyana* f. *harveyana* × *C. grandiflora* var. *grandiflora* f. *grandiflora*. Twenty-six F_1 hybrids of this cross were raised. Thus far, only 16 have bloomed; these 16 averaged 74% pollen stainability. One of the F_1 analyzed meiotically exhibited $n = 13$ at diakinesis and 13:13 distribution at anaphase I.

As the male parent, *C. grandiflora* var. *harveyana* f. *harveyana* was successfully hybridized with *C. grandiflora* var. *saxicola* and *C. lanceolata*; see these latter taxa for details.

9e. C. GRANDIFLORA Hogg *ex* Sweet var. HARVEYANA (A. Gray) Sherff forma DEMAREEI Sherff, Amer. J. Bot. 31:277. 1944.

TYPE: United States: Arkansas: Bradley Co., on prairies, Warren, *D. Demaree 19,262A*, 7 Jun 1939 (HOLOTYPE F!; ISOTYPE GA!).

Blooming: May-Jun. Habitat: Sandy prairie. Chromosome number: $n = 13$.

This form differs from f. *harveyana* in being rather densely short-pilose on the stem and flat surfaces of the leaves. Previously known only from the type locality (Sherff, 1955), it has been discovered by Marie P. Locke of Pine Bluff, Arkansas, growing also in Grant County in the parking lot of the Red Cockaded Woodpecker bird sanctuary, southeast of Sheridan (Fig. 18, closed stars). At the Grant County location both typical f. *demareei* and f. *harveyana* occur, as well as individuals with an intermediate degree of pubescence (leaf surfaces moderately short-pilose, stem mostly glabrous on internodes but rather densely short-pilose on and near the nodes. This is the only location known where apparent natural hybridization takes place between the two forms.

Forma *demareei* and f. *harveyana* were hybridized; four F_1 plants were medium-pilose with 97% average pollen stainability. In the F_2, 11 of 21 seedlings were albino; five of the 10 green seedlings survived to flowering. Only stem pubescence and pollen stainability were recorded on these: two were essentially glabrous (somewhat pubescent at the nodes), two were medium-pilose, and one was densely pilose; average pollen stainability was 89%. Forma *demareei* appears to differ by a single incompletely dominant gene from f. *harveyana*. The albino F_2 seedlings may have been just a chance occurrence in this particular cross or may represent products of a balanced lethal system which would help prevent gene exchange between the two forms.

9f. C. GRANDIFLORA Hogg *ex* Sweet var. LONGIPES (Hook.) T. & G., Fl. N. Amer. 2:345. 1842.

Coreopsis longipes Hook., Bot. Mag., *pl.* 3586. 1837.

TYPE: United States: Texas: *T. Drummond s.n.* (HOLOTYPE BM!).

Type material of the variety is still extant and would take precedence over the plate by Hooker (indicated as the type by Sherff, 1936).

Blooming: May. Habitat: Sandy roadsides, sandy woods, near railroad tracks. Chromosome number: $n = 39$ (hexaploid).

This variety is sometimes difficult to distinguish from var. *grandiflora* and var. *harveyana* but can usually be recognized by the combination of its broader leaf segments and larger achene aristae. It tends to be strongly stoloniferous and is hexaploid, while the other varieties are weakly stoloniferous and diploid. It is endemic to Texas (Fig. 18, triangles).

So far, I have not been able to secure hybrids of var. *longipes* with any other taxon in *Coreopsis*. Attempted hybridizations of var. *longipes* with *C. grandiflora* var. *grandiflora, C. grandiflora* var. *harveyana* (both typical and "heterolepis" phases), *C. grandiflora* var. *saxicola, C. leavenworthii, C. intermedia, C. nudata, C. tinctoria* var. *tinctoria,* and *C. tripteris* all failed.

II. Section SILPHIDIUM T. & G. *ex* A. Gray, Syn. Fl. N. Amer. I^2:294. 1884.
Sect. *Eucoreopsis* subsect. *Silphidium* T. & G., Fl. N. Amer. 2:341. 1842.
Subg. *Silphidium* F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.
Sect. *Latifoliae* F. Boynton *in* Small, Man. SE Fl. 1446. 1933.
Leiodon Shuttl.; Sherff, Field Mus. Nat. Hist., Bot. Ser. 11:416, as genus. 1936.

Herbaceous perennial; leaves opposite, simple, serrate; ray flowers four or five, lemon-yellow, sterile, the ligule elliptic-oblong and entire at the apex; disk flowers ca. 10-18, the corolla ca. 5.5-6 mm long, lemon-yellow, 5-toothed apically, with five anthers, the style tips deltoid in outline; palea linear, obtuse, glabrous, deciduous; achenes obcompressed, ca. 7 mm long, not winged, glabrous, bald at the apex. Section monospecific (*C. latifolia*). $x = 13$.

10. C. LATIFOLIA Michx., Fl. Bor.-Amer. 2:137. 1803.
Leiodon latifolium (Michx.) Shuttl., *nom. nud., in* Sherff, Field Mus. Nat. Hist. Bot. Ser. 11:416. 1936.

TYPE: United States: at higher altitude in the Carolina Mountains, *A. Michaux s.n.* (ISOTYPE P!).

Blooming: Aug.-Sep. Habitat: Rich, moist, shaded higher slopes. Chromosome number: $n = 13$.

Coreopsis latifolia (Fig. 19) is a rare, very distinctive, and primitive (Smith, 1975) species endemic to the mountains of the Carolinas and northeastern Georgia (Fig. 20, stars). Its closest relatives are in section *Electra* of the genus and occur in Mexico. In general habit, especially in the serrate leaf margins, it appears to have had some ancestry in common with *Bidens* (as perhaps, does the entire section *Electra;* cf. Smith, 1975).

I have not been able to obtain hybrids of *C. latifolia* with any other species of *Coreopsis*. Attempted hybridizations of *C. latifolia* with *C. grandiflora* var. *saxicola, C. grandiflora* var. *harveyana* "heterolepis" phase, *C. nuecensoides, C. basalis, C. major* f. *major, C. major* f. *oemleri* (hexaploid race),

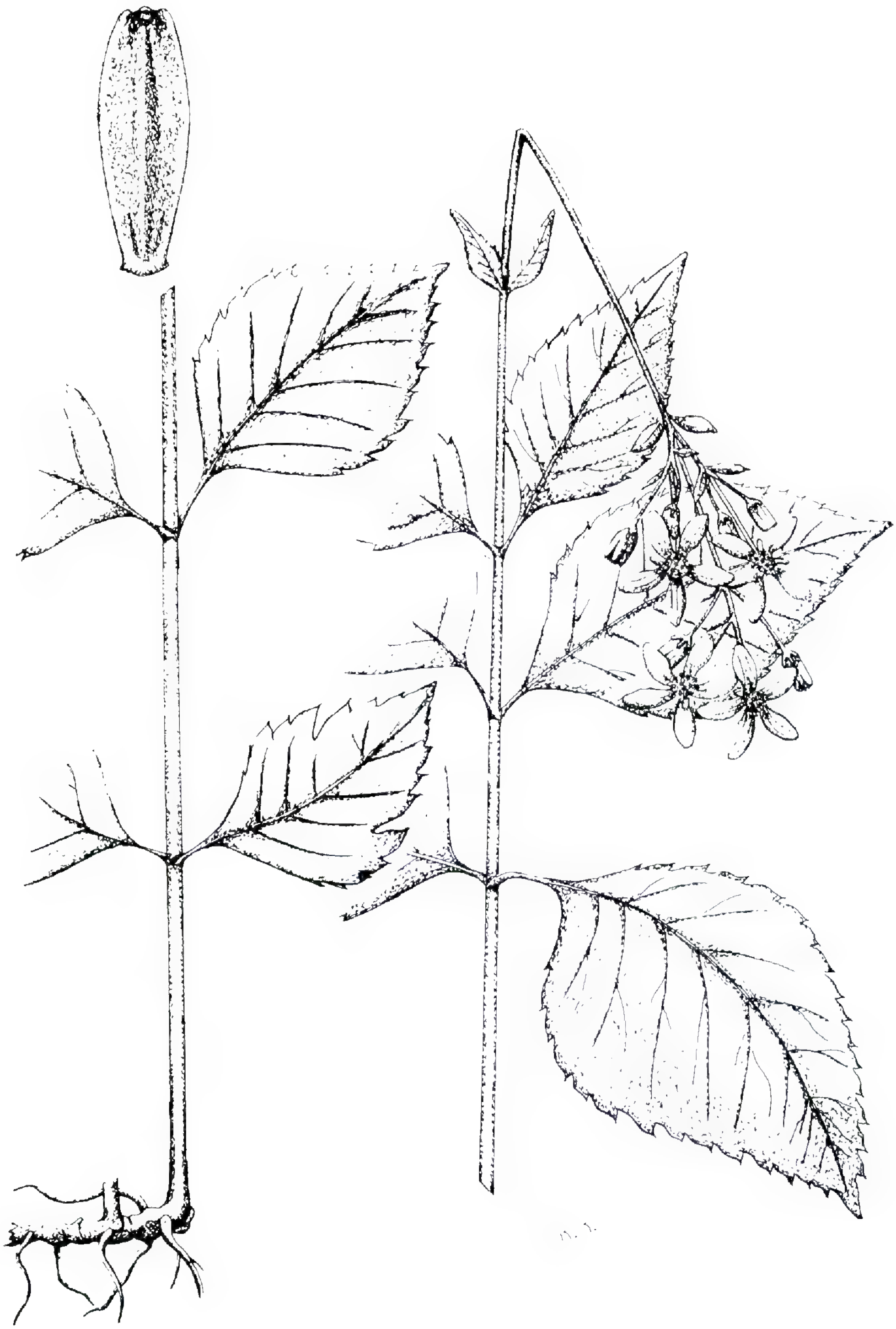


Fig. 19. *Coreopsis latifolia*; achene at upper left.

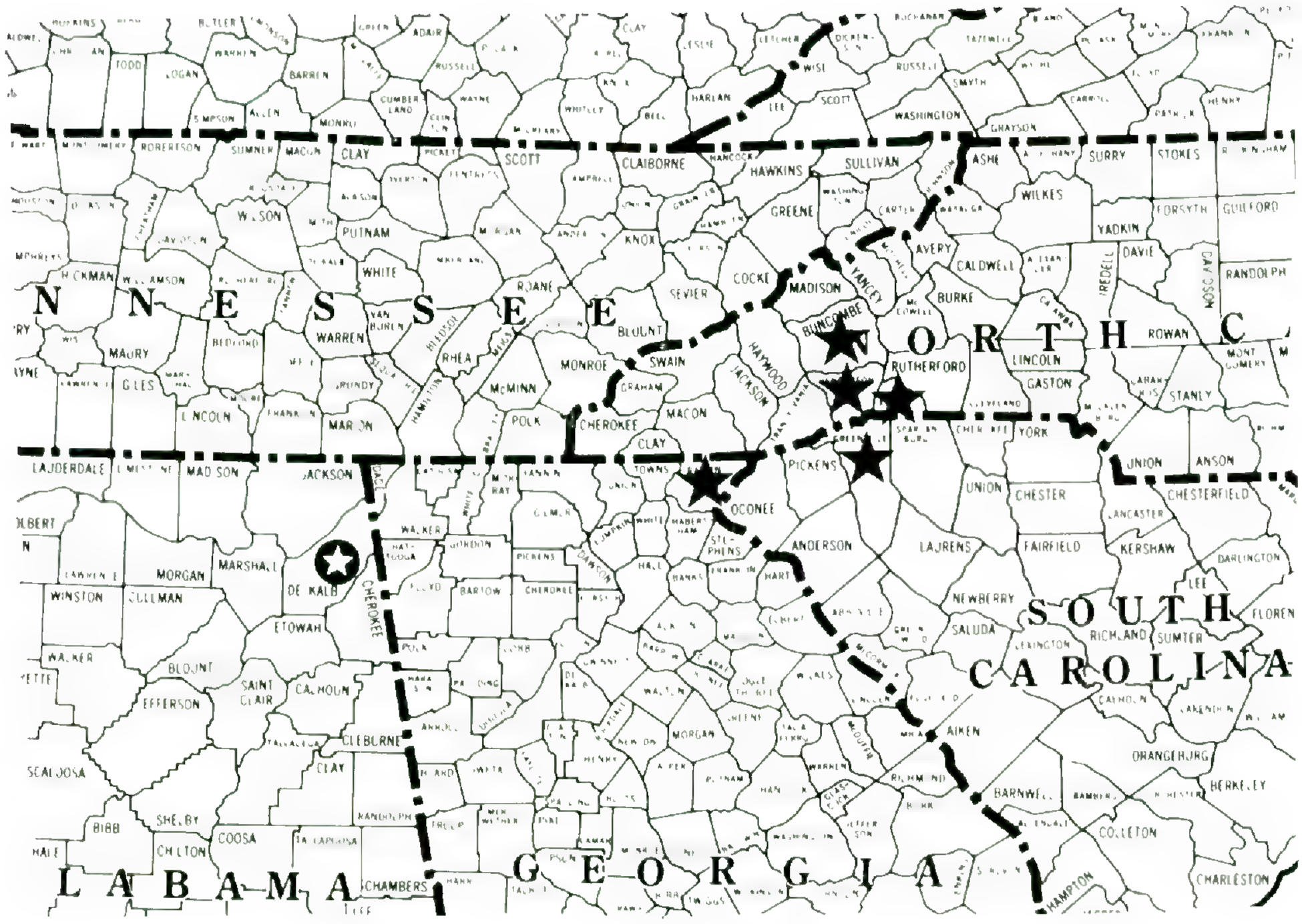


Fig. 20. Distribution of *C. latifolia* (black stars) and *C. pulchra* (white star in black circle). The exact county in northeastern Georgia for *C. latifolia* is unknown. *Coreopsis pulchra* may also occur in northwestern Georgia (Sherff, 1955).

C. pulchra, *C. tripteris*, *C. linifolia* (diploid race), and *C. intermedia* all failed. In several of these crosses, good achene set occurred, but the seedlings grown from the achenes were all normal *C. latifolia*. *Coreopsis latifolia* is apparently self-fertile (or possibly apomictic) when stimulated by pollen from related species. When heads of plants of *C. latifolia* were bagged and left bagged in the greenhouse, no achene set occurred.

III. Section PALMATAE F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Anacis Schrank (in part: *A. tripteris*), Denkschr. Königl. Akad. Wiss. München 5(Math. Naturw.):5, as genus. 1817.

Chrysostemma Less., Syn. Gen. Compos. 227, as genus. 1832.

Sect. *Gyrophyllum* Nutt., Trans. Am. Philos. Soc. II. 7:358. 1841.

Subg. *Anacis* F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Herbaceous perennials; leaves opposite, simple and entire or commonly palmately three-parted, the three leaflets entire to lobed or dissected; outer phyllaries adnate to the inner phyllaries and therefore arising about 1 or 2 mm above the base of the head; ray flowers about 6 to 8, lemon-yellow, the ligule elliptic-oblong and entire to slightly denticulate at the apex; disk flowers ca. 25-55, the corolla ca. 4.5-6 mm long, greenish-yellow to lemon-

yellow (or wine-purple apically), 5-toothed apically, with 5 anthers, the style tips deltoid to deltoid-caudate in outline; palea linear to filiform, dilated apically and obtuse or acute, glabrous, very tardily deciduous; achenes obcompressed, ca. 3-7 mm long, narrowly winged, glabrous, bidentate (the teeth often lacerate or plurisetose) at the apex. $x = 13$.

11. C. TRIPTERIS L., Sp. Pl. 908. 1753.

Anacis tripteris Schrank, Denkschr. Königl. Akad. Wiss. München 5(Math Naturw.):7. 1817.
Chrysostemma tripteris Less., Syn. Gen. Compos. 227. 1832.
Coreopsis tripteris var. β T. & G., Fl. N. Amer. 2:341. 1842.
Coreopsis tripteris var. *smithii* Sherff, Bot. Gaz. 88:301. 1929.
Type: United States: Alabama: Low open woods near Montgomery, *J. D. Smith s.n.* 26 Aug 1885 (HOLOTYPE F!).
Coreopsis tripteris var. *subrhomboidea* Sherff, Bot. Gaz. 88:303. 1929.
Type: United States: Texas: Bowie Co., sandy open woods bordering bog, near Texarkana, *E. J. Palmer 29421,* 27 Oct 1925 (HOLOTYPE GH!).
Coreopsis tripteris var. *intercedens* Standley, Rhodora 32:34. 1930.
Type: United States: Illinois: Edgewater, Chicago, *F. Gates 808,* 23 Aug 1905 (HOLOTYPE F).
Coreopsis tripteris var. *deamii* Standley, Rhodora 32:33. 1930.
Type: United States: Illinois: Henderson Co., dry bluffs, *H. N. Patterson s.n.,* Aug 1871 (HOLOTYPE F, Acq. No. 17866).

TYPE: None cited by Linnaeus. Habitat given as "Virginia". I am here designating the following neotype: United States: Virginia: Greensville Co., open woods NW of Taylor's Millpond. *M. L. Fernald & B. Long 11202,* 29 Aug 1939 (NEOTYPE F!).

Blooming: Jul-Sep. Habitat: Open woods, creek banks, roadside, prairies, railroad right-of-way. Chromosome number: $n = 13$.

Several varieties have been proposed within *C. tripteris* (Fig. 21; Fig. 22) on the basis of pubescence (vars. *intercedens & deamii*), entire leaves (var. *smithii*) versus the usual three-lobed leaves, and leaflet shape (var. *subrhomboidea*). In my opinion, all of these varieties lack merit. The pubescence of *C. tripteris* is variable, from essentially none to rather densely short-pubescent on the leaves and phyllaries. When observation is limited to local material, these variations may appear to merit recognition, but when viewed over the entire range of the species there is no clear-cut correlation of the pubescence types with geographical or ecological differences. Variously pubescent types often occur intermixed in the same local areas. It is possible that these pubescence types might be validly recognized as formae, but I prefer to simply merge them with the typical type.

The var. *smithii,* with "all or nearly all" leaves simple (Sherff, 1955), seems exceedingly weak to me since the "typical" variety bears simple leaves on the upper stem above the three-lobed median leaves. Depauperate

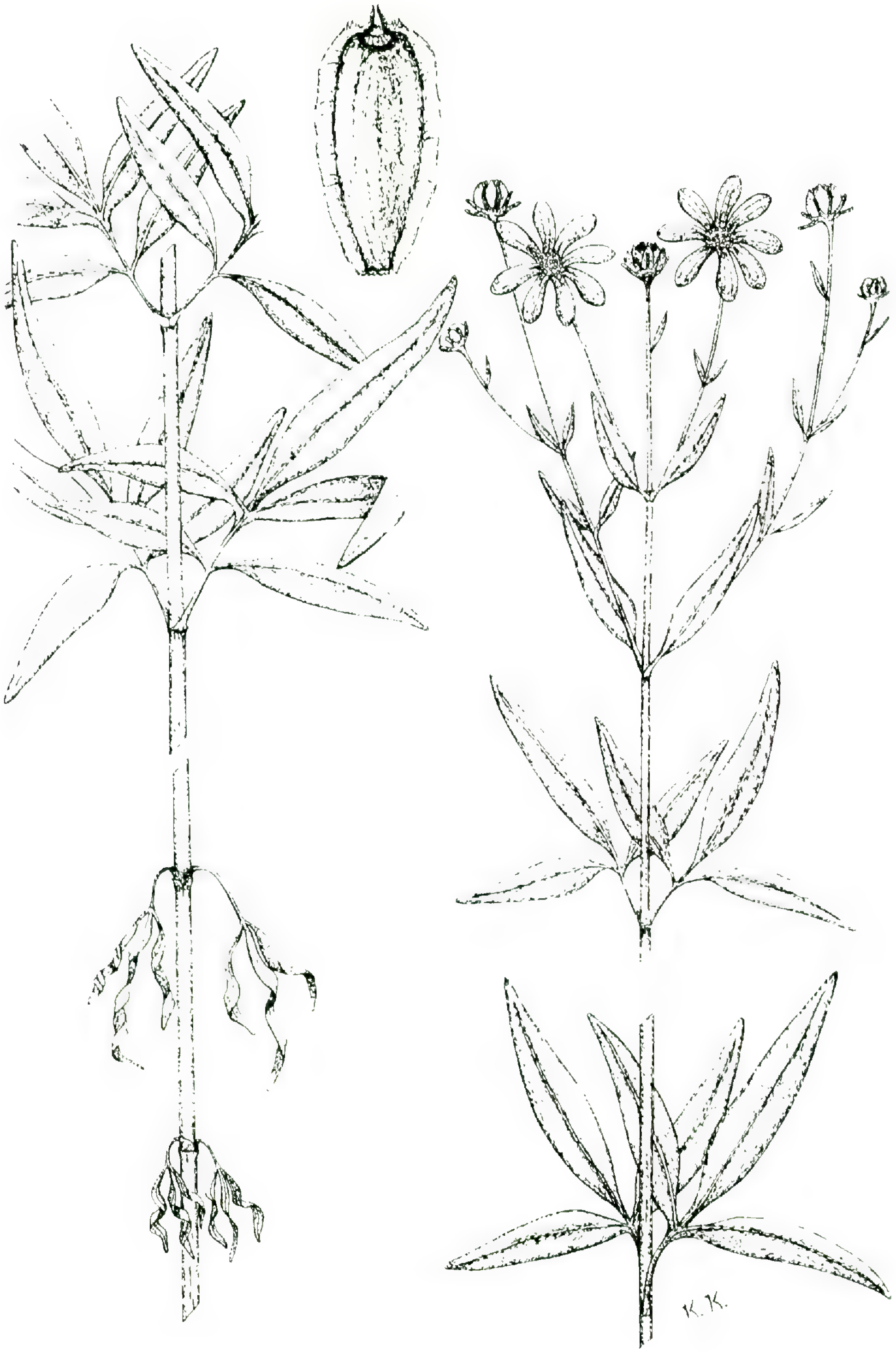


Fig. 21. *Coreopsis tripteris*; achene at upper center.

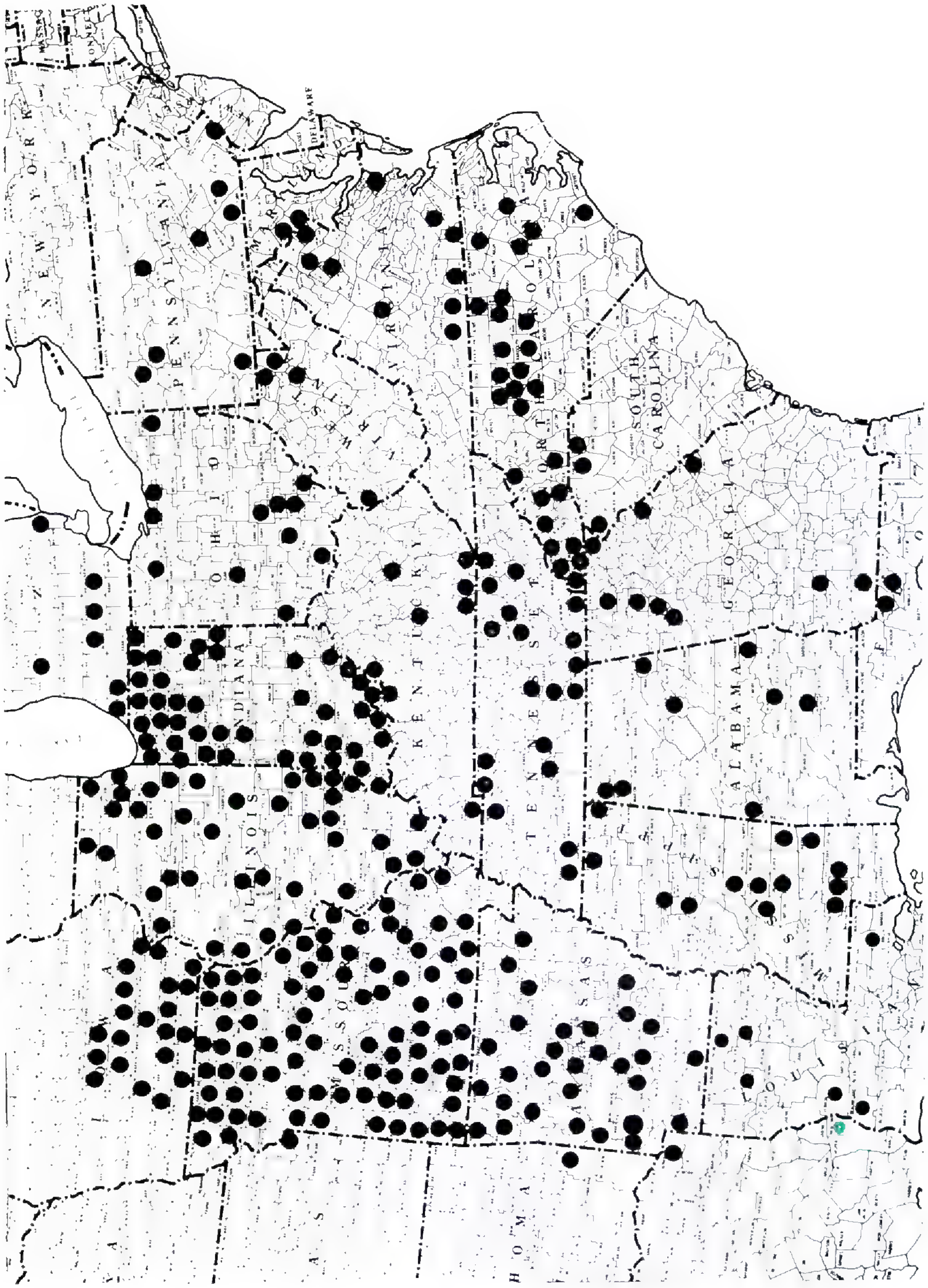


Fig. 22. Distribution of *C. tripteris*.

specimens often have leaves reduced in size as well as dissection; the var. *smithii* almost certainly represents merely a reduced growth form of the typical material.

While the most common leaflet shape in *C. tripteris* is narrowly lanceolate, the leaflets vary from nearly linear to oblong, elliptic-oblong, or even rhombic-elliptical. The somewhat rhomboidal shape of the leaflets of "var. *subrhomboidea*" represents merely population variation within *C. tripteris*.

The long-petiolate three-lobed leaves of this species clearly distinguish it from all other species of *Coreopsis* in eastern United States and Canada.

Attempted hybridizations of *C. tripteris* with *C. grandiflora* var. *grandiflora*, *C. grandiflora* var. *longipes*, *C. grandiflora* var. *saxicola*, *C. pubescens* var. *pubescens*, *C. intermedia*, *C. nuecensoides*, *C. lanceolata*, *C. rosea*, *C. leavenworthii*, *C. palmata*, *C. major* f. *major*, *C. verticillata* (tetraploid race), and *C.* ×*delphinifolia* all failed. In a few of these crosses, empty full-sized achenes were formed or a few selfed achenes.

Successful hybridizations involved only:

C. tripteris × *C. major* f. *oemleri* ($n = 39$). This hybridization was only very slightly successful: a single F_1 plant was obtained. Morphologically, the hybrid could have passed for *C. major* f. *oemleri*, although the leaves were short-petiolate (petioles ca. 2 mm long on median leaves; up to 6 mm long on lower leaves). The plant at pollen cell diakinesis exhibited $n =$ ca. 15^{I}, 8^{II}, 3^{III}, 3^{IV} but had pollen stainability of 89%. The plant has thus far produced no progeny. Because of the similarity of the F_1 hybrid to the *C. major* parent, it seems likely that natural hybrids between *C. tripteris* and *C. major* ($n = 39$), if they occur, would probably often pass undetected.

C. tripteris × *C. verticillata* ($n = 13$). This hybridization produced some very interesting F_1 hybrids (Fig. 23). The F_1 hybrids mimicked exactly the type material of *C.* ×*delphinifolia*! See that species for more details. Eight F_1 hybrids were grown; five of these averaged 43% pollen stainability. Two of the F_1 analyzed meiotically were $n = 13$ at diakinesis and exhibited 13:13 distribution at anaphase I. Despite the moderate pollen stainability and apparently normal chromosome pairing in meiosis, attempts to produce an F_2 and a BC_1 generation have thus far failed.

12. C. PALMATA Nutt., Gen. 2:180. 1818.

Calliopsis palmata Spreng., Syst. 3:611. 1826.

Coreopsis pauciflora Lehm.; Schlecht., Linnaea 10(Litt.-Ber.):76. 1836. (cited in Sherff, 1955).

Coreopsis praecox Fresen.; Schlecht., Linnaea 13(Litt.-Ber.):93. 1839. (cited in Sherff, 1955).

TYPE: None cited. Habitat given as "on the open plains of the Michigan Territory, Illinois, and Lower Louisiana." I am here designating the following neotype: United States: Arkansas: Benton Co., mesic grass prairie about 1 mi. NW of Rogers, *H. H. & G. S. Iltis 5549*, 19 Jun 1955 (NEOTYPE MINN!; ISONEOTYPE UARK!).

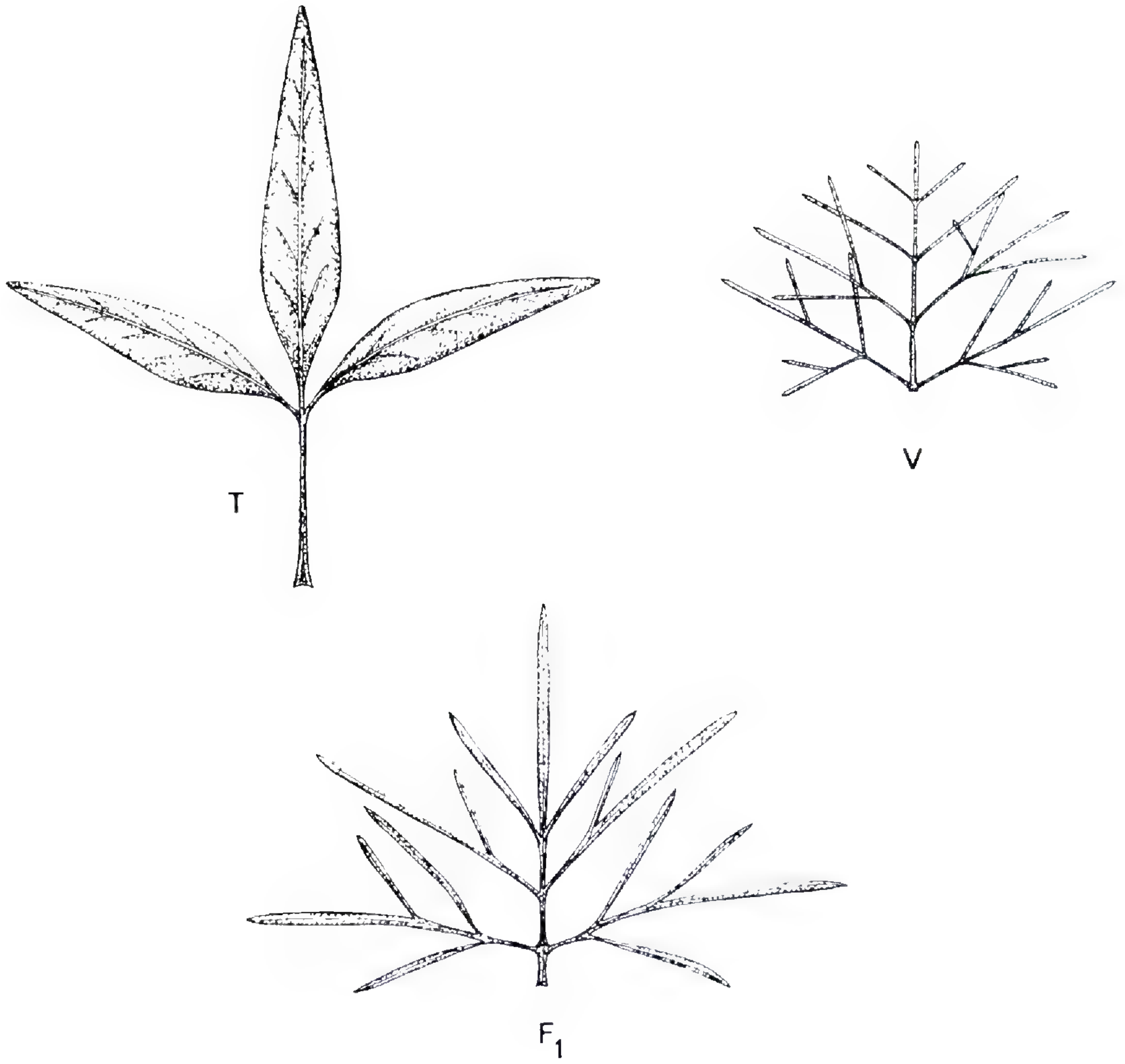


Fig. 23. Median leaves of *C. tripteris* (T), *C. verticillata* (V), and their artificial F_1 hybrid (F_1). The leaves of the artificial F_1 hybrid look exactly like the leaves of the type material for *C.* ×*delphinifolia*.

Blooming: Jun-Jul. Habitat: Open woods, rocky ridges, prairies, railroad right-of-way. Chromosome number $2n = 26$.

This species (Fig. 24; Fig. 25) is very distinct in its palmately-lobed leaves. It grew poorly in the greenhouse and consequently was not used in as many attempted hybridizations as I would have liked. All hybridizations attempted with *C. palmata* as one of the parents failed, including *C. palmata* with *C. major* f. *major*, *C. major* f. *oemleri* (both $n = 13$ and $n = 39$), *C. verticillata* ($n = 13$), *C. pulchra*, *C. tripteris*, *C. pubescens* var. *pubescens*, and *C. lanceolata*.

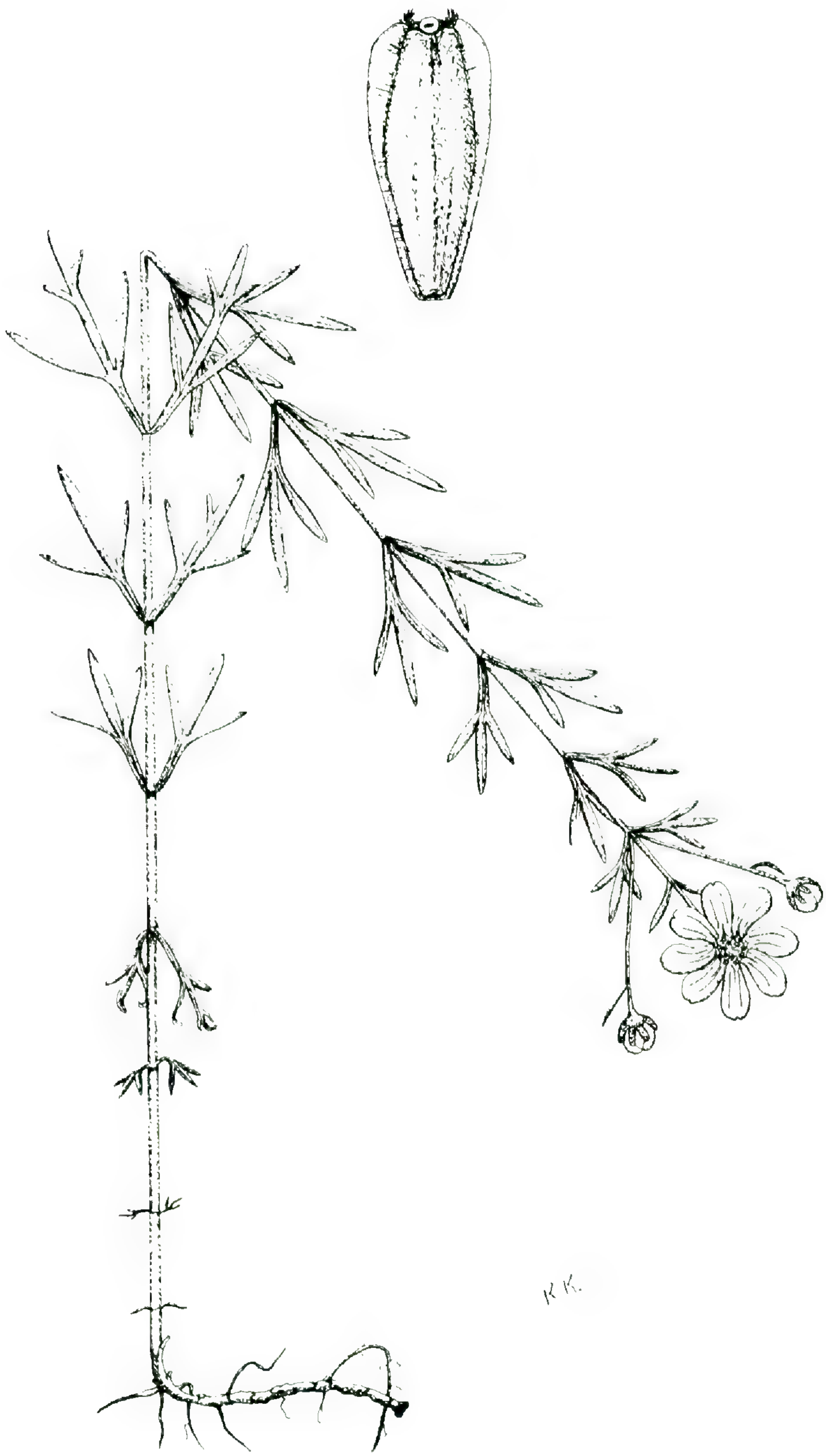


Fig. 24. *Coreopsis palmata*; achene at upper center.

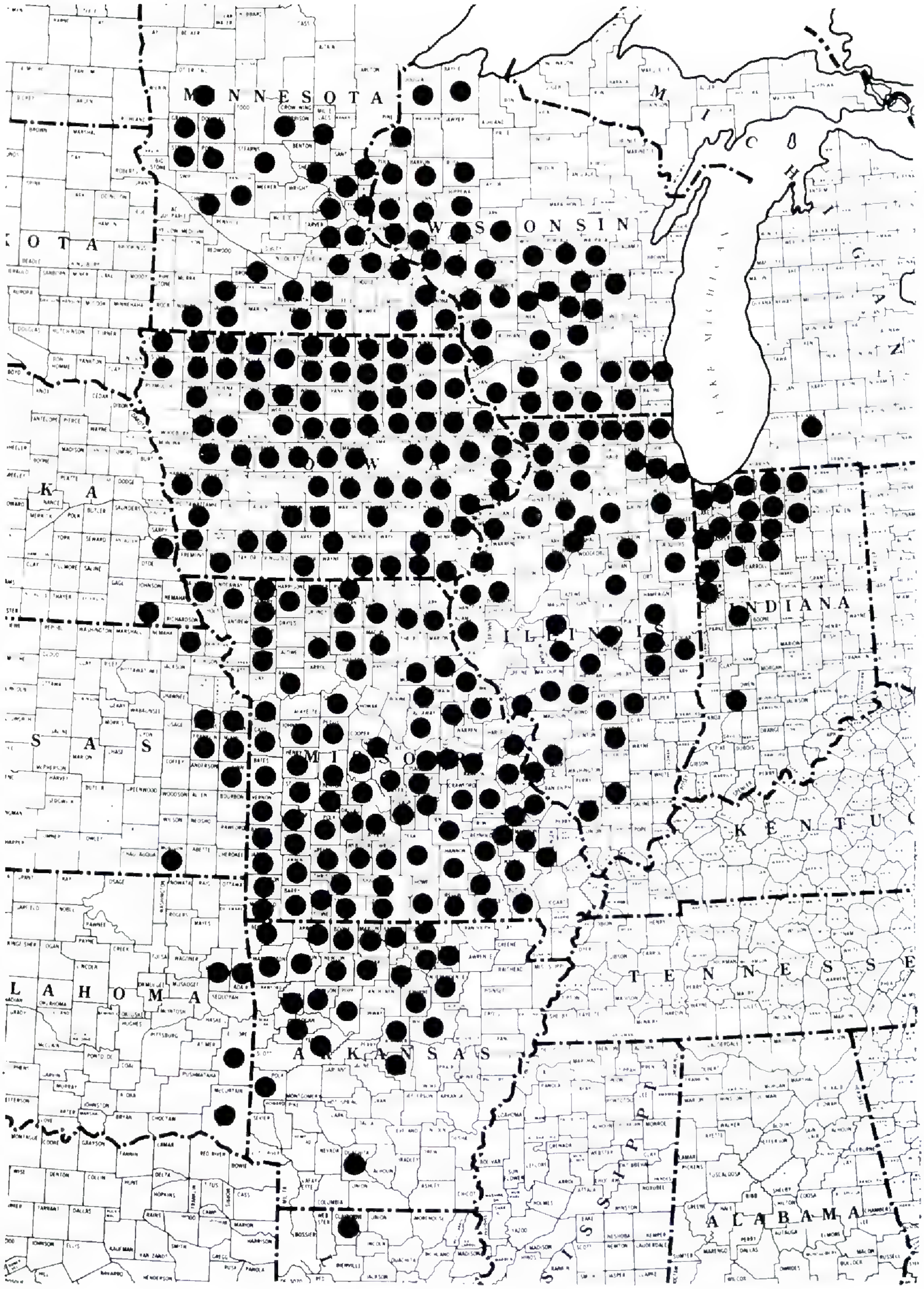


Fig. 25. Distribution of *C. palmata*.

13a. C. MAJOR Walt., Fl. Car. 214. 1788, forma MAJOR

Coreopsis senifolia Michx., Fl. Bor.-Am. 2:138. 1803.

TYPE: None cited. Sherff (1955) stated that "the remnants of Walter's collection . . . are in London" at the British Museum. Apparently no type material of *C. major* f. *major* is preserved there, however, since Dr. R. Ross of that institution (pers. comm.) has indicated that none of the material in the Walter folio can be referred to *C. major*. I am here designating the following neotype: United States: Mississippi: Jackson Co., Ocean Springs, *S. M. Tracy 4360,* 10 Jun 1898 (NEOTYPE NY!; ISONEOTYPE F!).

Blooming: late May-Aug(Sep). Habitat: Open woods, rocky slopes, sandy roadsides. Chromosome number: $n = 13$.

This form (Fig. 27, open stars) has previously been recognized as var. *major*. It commonly occurs intermixed in the same population with the nearly glabrous f. *oemleri* ($n = 13$ race). The two forms are completely interfertile, based on the results of artificial hybridizations mentioned below.

Attempted hybridizations of *C. major* f. *major* with *C. grandiflora* var. *grandiflora, C. grandiflora* var. *harveyana* "heterolepis" phase, *C. intermedia, C. gladiata, C. linifolia* ($n = 13$ race), *C.* ×*delphinifolia, C. verticillata* ($n = 13$ race), *C. palmata,* and *C. tripteris* all failed.

The only successful cross completed was: *C. major* f. *major* × *C. major* f. *oemleri* ($n = 13$ race). Twelve F_1 hybrids were obtained. Four of these had sparsely pubescent leaves and essentially glabrous outer phyllaries and would have keyed to *C. major* f. *oemleri*; eight had sparsely to medium-pubescent leaves and rather densely pubescent outer phyllaries and would have keyed to f. *major*. Four of the F_1 hybrids averaged 71% pollen stainability. The cross has thus far not been carried to the F_2. The results suggest that f. *major* and f. *oemleri* ($n = 13$) differ by a single probably incompletely dominant gene.

13b. C. MAJOR Walt. forma OEMLERI (Ell.) Sherff, Bot. Leafl. 6:4. 1952.

Coreopsis senifolia Michx. var. *rigida* Nutt., Gen. 2:180. 1818.

Coreopsis oemleri Ell., Bot. S.C. & Ga. 2:435. 1823.

Coreopsis wrayi Nutt., J. Acad. Nat. Sci. Philadelphia 7:76. 1834.

Coreopsis stellata Nutt., J. Acad. Nat. Sci. Philadelphia 7:76. 1834.

Coreopsis senifolia sensu Hook., Bot. Mag. *pl.* 3484. 1836 (not *C. senifolia* Michx 1803).

Coreopsis rigida Nutt., Trans. Amer. Philos. Soc. II. 7:358. 1841.

Coreopsis delphinifolia Lam. var. *rigida* T. & G., Fl. N. Amer. 2:342. 1842.

Coreopsis senifolia Michx. var. *stellata* T. & G., Fl. N. Amer. 2:342. 1842.

Coreopsis major Walt. var. *oemleri* Britton *ex* Small & Vail, Mem. Torrey Bot. Club 4:131. 1894.

Coreopsis major Walt. var. *rigida* (Nutt.) F. Boynton *in* Small, Fl. SE.

U.S. 1276 & 1340. 1903.

Coreopsis major Walt. var. *stellata* (Nutt.) B. L. Robinson, Rhodora 10:68. 1908.

Coreopsis major Walt. var. *stellata* (Nutt.) B. L. Robinson forma *oemleri* (Ell.) Sherff, Bot. Leafl. 6:4. 1952.

The name *oemleri* must be taken up as the forma designation (as contrasted to *stellata*) since it has priority in the forma category.

TYPE: United States: South Carolina: Richland Co., near the junction of the Broad and Saluda rivers, vicinity of Columbia, *Oemler s.n.*

While Sherff (1936, 1955) mentioned the collector and type locality, he did not indicate the herbarium in which the type resides. I have thus far not located the type specimen.

Blooming: mid May-Aug(Sep). Habitat: Open woods, rocky slopes, sandy roadsides. Chromosome number: $n = 13$, 39 (two races).

A great deal of variation exists in this form (Fig. 26; Fig. 27, dots), as indicated in part by the long list of synonymy. The leaves vary from entire (formerly recognized as var. *stellata* f. *oemleri*) to palmately divided into three leaflets that are flexible and spreading (formerly recognized as var. *stellata* f. *stellata*) or somewhat rigid and rather erect (formerly recognized as var. *rigida*). In addition, the leaflets vary from narrowly to broadly elliptical and the middle leaflet is sometimes three-lobed (Fig. 27, white star in black circle). Individuals with three-lobed middle leaflets are concentrated in eastern Georgia and southern South Carolina, indicating probable introgression of the hexaploid phase of f. *oemleri* with *C.* ×*delphinifolia* in this area. I am including individuals with narrowly linear leaflets (formerly recognized as var. *linearis*) in *C.* ×*delphinifolia*.

To complicate matters, there are two known chromosomal races in the form: $n = 13$ and $n = 39$. A very preliminary chromosome number survey suggests that populations west of the Allegheny Mountains (Tenn., W. Va., Ky., Miss., Ala., western bootheel of Fla., and western Ga.) are $n = 13$, while populations east and south of the Allegheny Mountains (Va., N.C., S.C., and northeastern Ga.) are $n = 39$. Many more chromosome counts would be necessary to establish these ranges for the chromosome races.

The $n = 13$ race has pollen diameter of about 24-28(-30) μ; the $n = 39$ race has pollen diameter of about (28-)30-33 μ. The two are so similar morphologically that they cannot be distinguished with certainty, without chromosome counts. The $n = 13$ race is interfertile with f. *major* (see above) and apparently differs from it in a single gene. The $n = 39$ race is probably interfertile with and does morphologically grade into *C.* × *delphinifolia*. This entire complex has been called the "*C. major* complex" (Gilbert, 1940), with good justification. It evidently represents a polyploid pillar complex where three clearly distinct diploid species (*C. major*, *C. tripteris*, *C. verticillata*) have hybridized in a complex fashion, perhaps at several polyploid levels (see discussion under *C.* ×*delphinifolia*) and have

Fig. 26. *Coreopsis major* f. *oemleri*; achene at upper center.

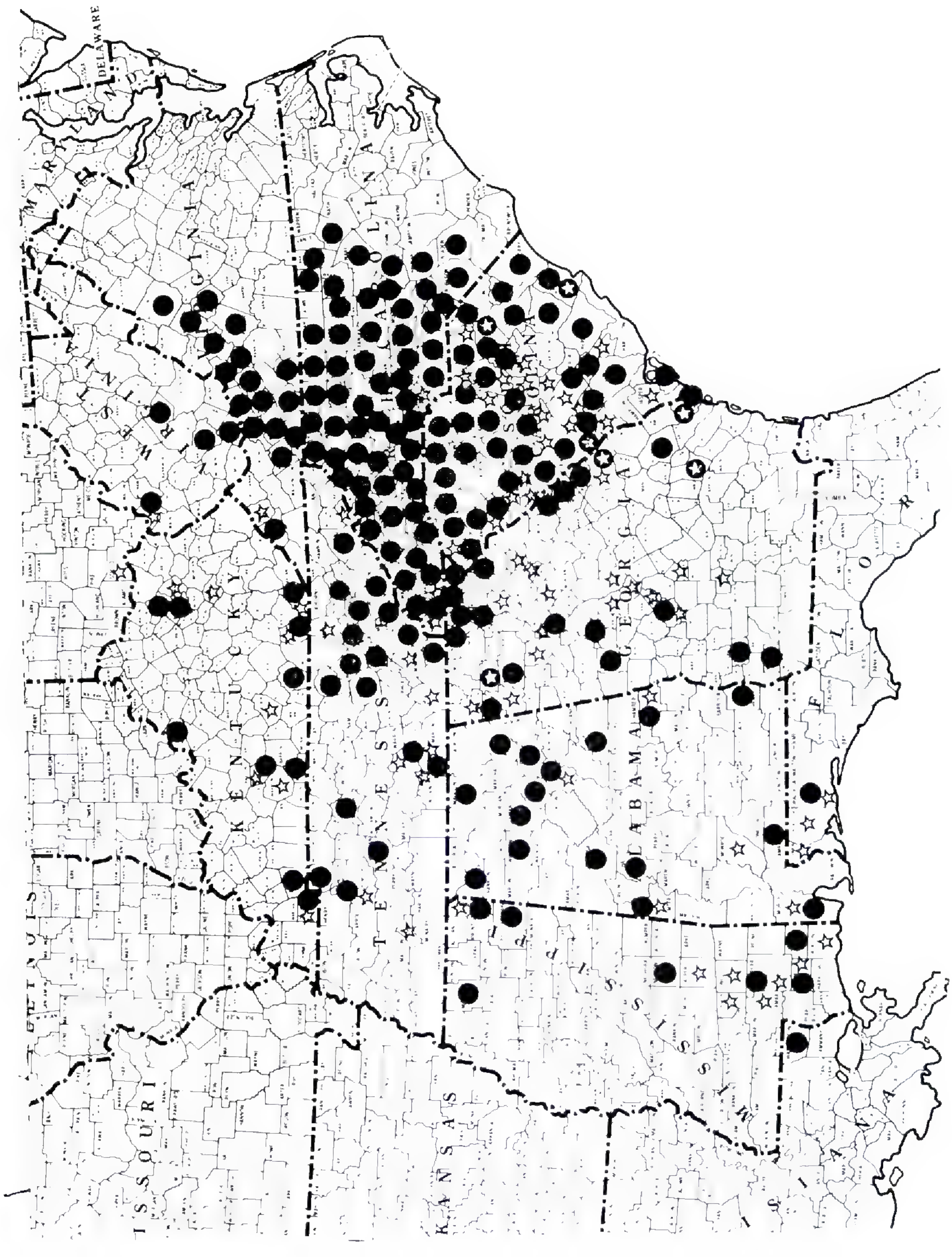


Fig. 27. Distribution of *C. major*. stars = *C. major* f. *major*; dots = *C. major* f. *oemleri*, with all leaflets entire; white stars in black circles = *C. major f. oemleri*, with the middle leaflets of some leaves 2- or 3-lobed.

also given rise to autopolyploid races (tetraploid, hexaploid), some of which are interfertile with the complex polyploid hybrid derivatives. This results in a mixing of the characteristics of the diploid species at the polyploid level such that a complex series of intergrading polyploid forms tend to morphologically interconnect the otherwise distinct diploids. Figure 28, drawn from field-collected material, indicates some of the intergradation exhibited by the *C. major* complex. Figure 29 indicates the intergradation that occurs in the complex in leaflet length and width, based on 128 specimens sampled from NCU.

I have indicated above that the "varieties" *major* and *stellata* ($n = 13$) are interfertile and should be reduced to formae. Form *oemleri* was based on material with all or nearly all leaves entire. But this entire-leaved material is rather clearly merely a growth phase of the usual three-leaflet state. I transplanted entire-leaved individuals into the greenhouse for use in hybridizations, and they produced three-leaflet leaves in the second year of growth. Form *oemleri* should hence be expanded to include both the entire-leaved and three-leaflet leaved phases. Variety *rigida* is represented by the $n = 39$ race, but cannot be adequately distinguished on the basis of rigidity of leaves nor the tendency for the leaflets to be held erect; there is complete intergradation with the typical phase in these characters, so that "var. *rigida*" should be merged with f. *oemleri*.

This presents a taxonomic dilemma: one could segregate these species on the basis of chromosome number and breeding behavior (in which case one would place the $n = 13$ and $n = 39$ races of f. *oemleri* in separate species, even though they are not distinguishable morphologically) or one could segregate them on the basis of morphology (in which case one would place the probably interfertile $n = 39$ race of *oemleri* and *C.* ×*delphinifolia* in separate species). In the first case one is at odds with the morphological species concept and in the latter case one is at odds with the biological species concept. I have chosen the latter course, largely in recognition of the fact that a taxonomic scheme must have utility to the non-specialist.

In attempted hybridizations with the diploid ($n = 13$) race, *C. major* f. *oemleri* × *C. gladiata* and *C. palmata* failed.

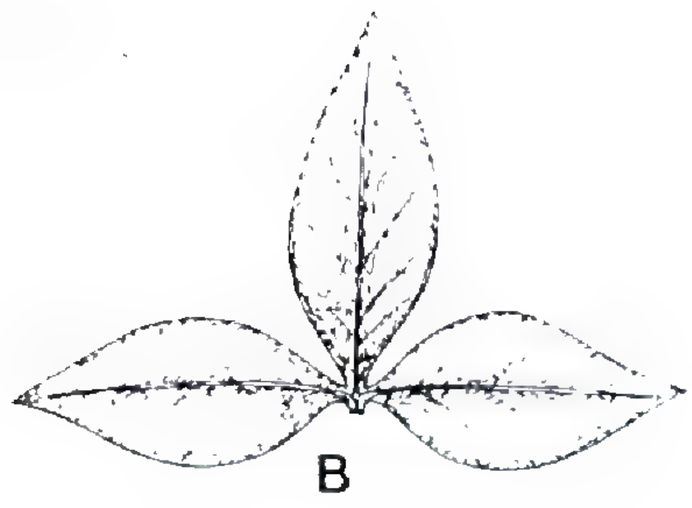
Successful hybridizations included:

C. major f. *oemleri* ($n = 13$) × *C. major* f. *major*. This hybridization is mentioned under forma *major*.

C. major f. *oemleri* ($n = 13$) × *C. pulchra*. Five F_1 hybrids of this combination were obtained. They resembled ordinary f. *oemleri*, but had disk

Fig. 28. Intergradation in leaf morphology in the *C. major complex*, drawn from field-collected material. A = *C. major* f. *oemleri*; B = *C. major* f. *major*; C = *C. major* f. *oemleri*, entire-leaved phase; D-E = material approaching *C.* ×*delphinifolia*; F-J = various phases of *C.* ×*delphinifolia*.

A


B

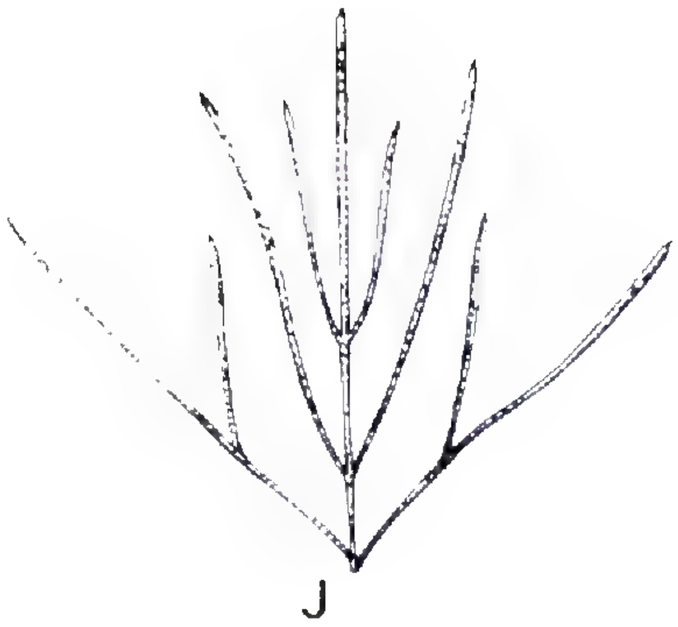
H

I

C

G

D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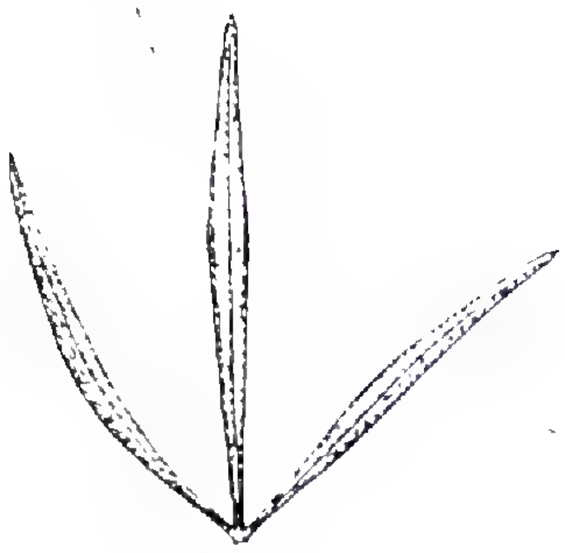
F

E

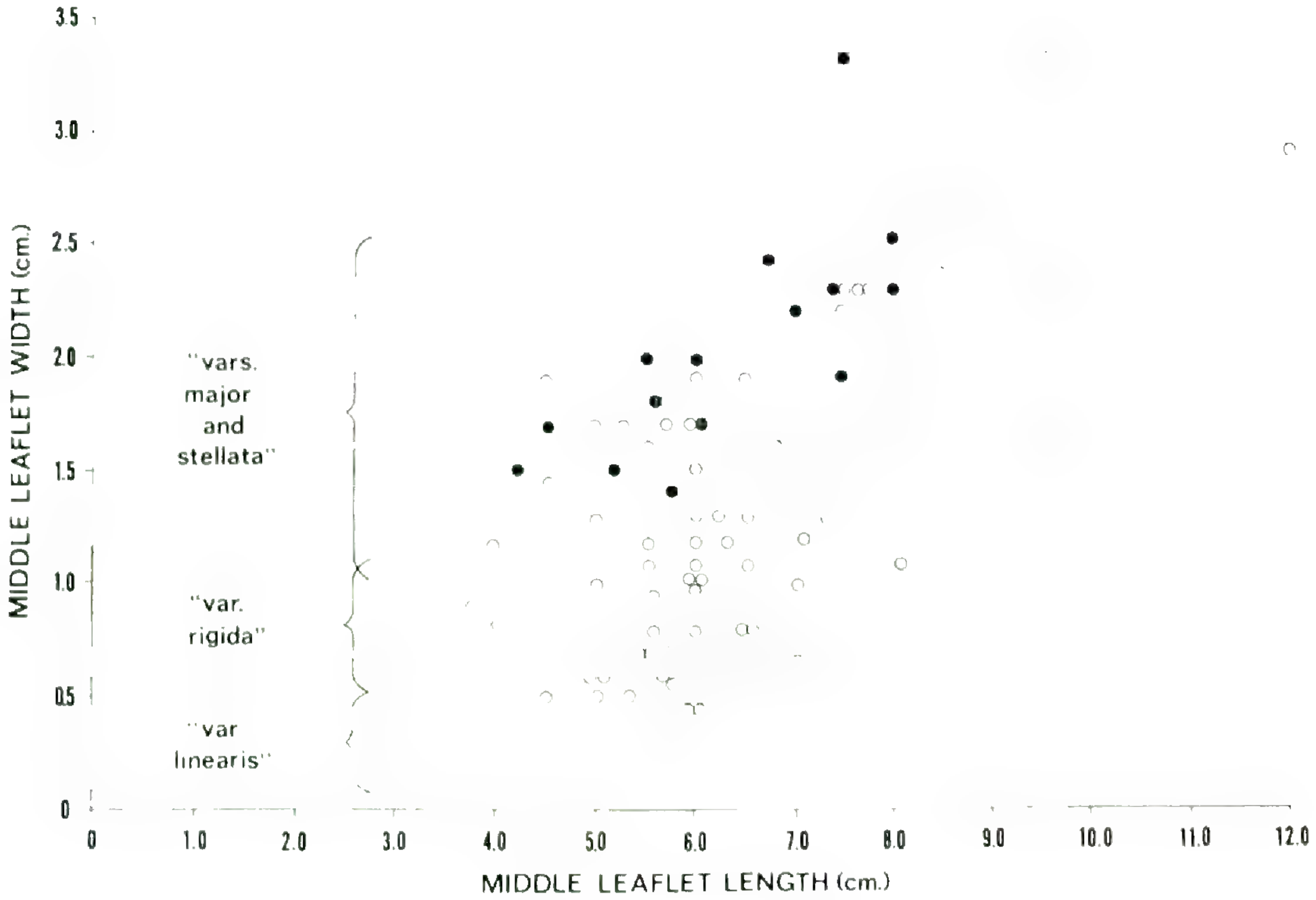

Fig. 29. Intergradation in leaflet length with width in the *C. major* complex. The "varieties" *major*, *stellata*, *rigida*, and *linearis* are indicated on the basis of leaflet widths given by Sherff (1955). Open circles = leaves sparsely pubescent to glabrous; closed circles = leaves medium to densely pubescent.

flowers apically reddish-brown. Three of these averaged 52% pollen stainability. One F_1 plant at diakinesis of pollen meiosis was $n = 13$. The F_1 plants failed to set fruit.

In attempted hybridization of the hexaploid ($n = 39$) race, *C. major* f. *oemleri* × *C. intermedia*, *C. latifolia*, *C. grandiflora* var. *saxicola*, *C. grandiflora* var. *harveyana* "heterolepis" phase, *C. pubescens* var. *pubescens*, *C. nuecensoides*, *C. basalis*, *C. wrightii*, *C. lanceolata*, *C. rosea*, *C. gladiata*, *C. falcata*, *C. leavenworthii*, *C. palmata*, and *C. tripteris* all failed.

The hexaploid race did hybridize with *C.* ×*delphinifolia;* see that species for details.

14. C. ×DELPHINIFOLIA Lam., Encyc. 2:108. 1786.
    Ceratocephalus delphiniifolius Vaill. *ex* Ehret, Pl. et Pap. Rar. Depict. *pl.* 9, I. 1749.
    Coreopsis verticillata of Curtis, Bot. Mag. *pl.* 156. 1791.
    Coreopsis verticillata L. var. *linearis* Michx., Fl. Bor.-Am. 2:139. 1803.
    Coreopsis discolor Link., Enum. Horti Berol. 2:353. 1822.
    Coreopsis major Walt. var. *linearis* Small, Bull. Torrey Bot. Club 22:48.

1895. Type: United States: Georgia: DeKalb Co., Little Stone Mt., *J. K. Small s.n.*, 7 Jul 1893 (HOLOTYPE NY!; ISOTYPE NY!).

Coreopsis delphiniifolia Lam. ex Ind. Lond. 2:294. 1930 (orthographic variant).

Coreopsis delphinifolia Lam. var. *chlooidea* Sherff, Bot. Gaz. 94:596. 1933. Type: United States: Alabama: in pine woods, mountains of Alabama, *S. B. Buckley s.n.* (HOLOTYPE GH!, specimen on right side of sheet).

Coreopsis delphinifolia Lam. var. *linearis* Sherff, Brittonia 6:341. 1948. *Coreopsis delphinifolia* Lam. var. *delphinifolia* forma *concolor* Sherff, Bot. Leafl. 6:5. 1952. Type: United States: Georgia: Tattnall Co., moist swale in sandhills 3 mi NW of Reidsville, *A. Cronquist 5598*, 3 Aug 1948 (HOLOTYPE GA!; TOPOTYPE, *A. Cronquist 5345* GA!).

TYPE: Founded on the illustration of *Ceratocephalus delphiniifolius* Vaill. by Ehret (loc. cit.) and supported by material cultivated in the King's Garden at Paris (ISOTYPE P!).

Blooming: late May-Jul(Sep). Habitat: Open rocky woods, sand hills, savannas, pine barrens, near sphagnum swamps. Chromosome number: $n = 26$, 39, ca. 52.

As mentioned under *C. tripteris*, the type material of this species matches exactly the morphology of the *C. tripteris* × *C. verticillata* ($n = 13$) artificial F_1 hybrid. The species occurs in South Carolina and Georgia (Fig. 30), with "typical" material (leaflets dissected) being concentrated in eastern Georgia and southern South Carolina.

I was puzzled, upon examining the type material of *C.* ×*delphinifolia*, that none of the field-collected material I had observed matched the morphology of the type. The field-collected material commonly has less dissected leaves and wider leaf segments than the type material, and the terminal portions of the leaf segments tend to be acuminate rather than blunt as in the type material. After having made the *C. tripteris* × *C. verticillata* ($n = 13$) hybrid, and in view of the chromosome numbers and considerable morphological diversity of the field populations, I came to realize that the species was founded on a cultivated F_1 hybrid but that the field populations represent a complex of intergrading polyploids at the tetraploid, hexaploid and octoploid levels, derived from earlier hybridization between *C. tripteris*, *C. verticillata*, and (probably) *C. major*. The polyploid levels are characterized by narrow leaflets, commonly with the median leaflet at least deeply three-lobed and the lateral leaflets at least deeply two-lobed, producing a dissected leaf with the segments commonly 2-5 mm wide (Fig. 28, F-J). Unfortunately (for purposes of clarity in taxonomy) the species apparently is interfertile with and does intergrade somewhat with the hexaploid race of *C. major* f. *oemleri*. It seems proper to recognize the complex of forms with narrow leaflets that are commonly dissected as *C.* ×*delphinifolia*.

I do not believe it is useful to segregate var. *linearis* and var. *chlooidea*, both based on very narrow leaflets. Leaflet width is variable in the complex,

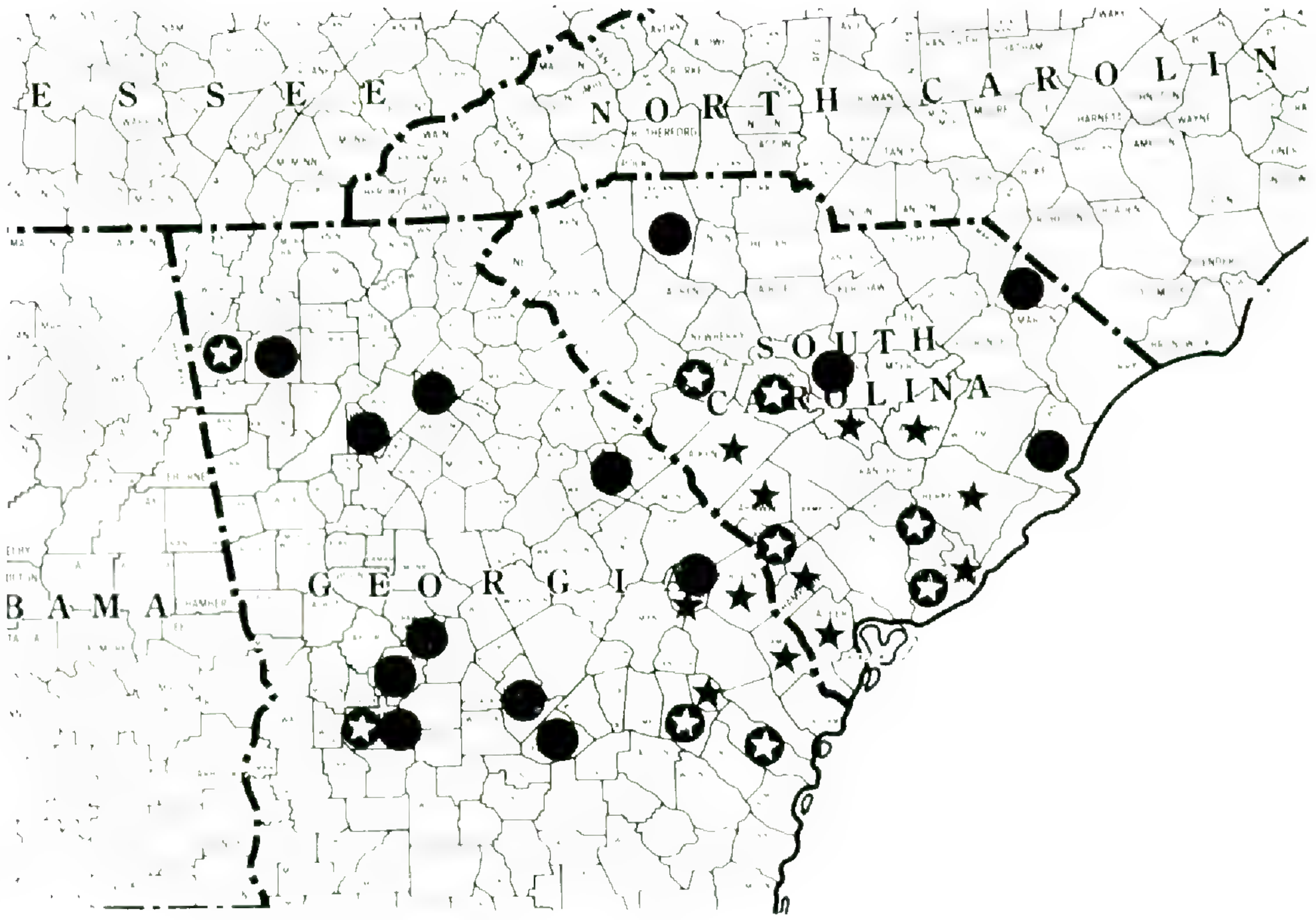

Fig. 30. Distribution of *C.* ×*delphinifolia*, white star in black circle = leaflets divided into several segments; black star = middle leaflets 2- or 3-lobed, lateral leaflets entire; dot = all leaflets entire.

within populations, and to some degree within individuals. One specimen of *C.* ×*delphinifolia* that I transplanted to the greenhouse and trimmed back (to increase the probability of surviving the transplantation) had produced leaflets 3-4 mm wide, the median one apically three-lobed in the field; leaflets on the regrowth in the greenhouse were all entire and as much as 9 mm wide!

Form *concolor* is likewise of doubtful utility. The disk flowers of *C. verticillata* and *C. major* in this section are at first lemon-yellow (or greenish-yellow) and become purplish-brown with age after anthesis. Those of *C. tripteris* darken similarly, or are purplish from the beginning. The disk flowers of *C.* ×*delphinifolia* are commonly (greenish-) lemon-yellow to slightly tinged purplish-brown and darken irregularly with age. I can see little utility in recognizing a few individuals as a separate form because they happen to have entirely yellow disk flowers in the beginning.

Attempted hybridizations of *C.* ×*delphinifolia* ($n = 39$) with *C. verticillata* ($n = 13$), *C. tripteris*, *C. major* f. *major*, and *C. auriculata* all failed. One hybridization with *C. major* f. *oemleri* ($n = 39$) was successful. The *C. major* parent had entire leaflets ca. 9 mm wide; the *C.* ×*delphinifolia* parent had the middle leaflet three-lobed and the lateral leaflets two-lobed or entire,

with the leaf segments ca. 3 mm wide. The F_1 hybrids had middle leaflets three-lobed and lateral leaflets two-lobed or entire, with leaf segments 3 to 8.5 mm wide. Of nine hybrids, seven would have keyed to *C.* ×*delphinifolia* and two would have keyed to *C. major* f. *oemleri*. The hybrids were vegetatively vigorous and had high pollen stainability (the exact percentage was not measured). Another successful hybridization with *C.* ×*delphinifolia* was an intraspecific cross involving individuals that both had linear, entire leaflets (leaflets not dissected). Nineteen F_1 progeny of this cross all had narrow, entire leaflets.

The octoploid material ($n = 52$) of *C.* ×*delphinifolia* was only recently discovered in populations from Aiken and Lexington counties in South Carolina and no hybridizations have been attempted with it. It has pollen diameter of about 30-32 μ.

15. C. PULCHRA F. Boynton *in* Small, Fl. SE. U.S. 1277 & 1340. 1903.

TYPE: United States: Alabama: northern Alabama, *Biltmore Herbarium 14728*. Formerly at the Biltmore Herbarium, but "doubtless was destroyed" (Sherff, 1936) by floodwaters. I am here designating the following neotype: United States: Alabama: DeKalb Co., common in thick moss over layers of sand on flat sandstone outcrop ca. 100 feet on dirt road from blacktop road 89 in De Soto State Park, 1.2 mi. NW of Park Office, *E. B. Smith 1717*, 27 Jun 1972 (NEOTYPE UARK!).

Blooming: late Jun-Sep. Habitat: Damp sandy soil in open woods, on or near sandstone outcrops. Chromosome number: $n = 13$.

This species (Fig. 31; Fig. 20, white star on black circle) is evidently closely related to *C. verticillata* but differs consistently in its telescoped stem, leaf segments enlarged apically (rather than linear-filiform) and the rather dark purplish-brown apices of the disk flowers; it is geographically isolated from *C. verticillata*. Plants transplanted to the greenhouse maintained these differences (although the stems tended to become more elongated).

Attempted hybridization of *C. pulchra* with *C. palmata* and *C. latifolia* failed.

Coreopsis pulchra (as the pollen parent) hybridized with *C. major* f. *oemleri* ($n = 13$) and with *C. verticillata* ($n = 13$); see the latter two species for details.

16. C. VERTICILLATA L., Sp. Pl. 907. 1753.

Coreopsis tenuifolia Ehrh., 7:168. 1792.

Coreopsis verticillata L. var. *tenuifolia* Michx., Fl. Bor.-Am. 2:139. 1803.

Bidens verticillata Baillon; B. D. Jackson, Ind. Kew. 1:301. 1893 (not *Bidens verticillata* L. 1753).

TYPE: United States: Virginia (as then bounded): material collected by *John Clayton* and represented by a specimen of the "Herb. Gronovii" (LECTOTYPE BM!).

Blooming: Jun-Jul. Habitat: Edge of woods, sandy roadsides, shale em-

Fig. 31. *Coreopsis pulchra;* achene (not completely filled) at upper right.

bankments, meadows. Chromosome number: $n = 13, 26$ (two races).

The distribution given by Sherff (1936, 1955) for *C. verticillata* is seriously in error. He included Georgia, Florida, Alabama, and (presumably) Tennessee in its range and noted that some authors reported it in Kentucky and Nebraska. The range is actually only from Maryland and West Virginia to South Carolina (Fig. 32). Sherff obviously was confusing *C. grandiflora* var. *harveyana* with *C. verticillata* (I have run across quite a few specimens of the former that were annotated by Sherff as the latter) and was accepting uncritically the misidentifications of other authors. *Coreopsis verticillata* and *C. grandiflora* var. *harveyana* are superficially similar but are easily distinguishable by a number of characters among which are:

C. verticillata	*C. grandiflora* var. *harveyana*
Leaves *palmately* compound	Leaves *pinnately* compound
Largest leaves near the middle of the stem.	Largest leaves near the base of the stem.
Ligules narrowly elliptical, entire or nearly so at apex.	Ligules cuneate, 4- or 5-toothed at the apex.
Outer phyllaries adnate to inner phyllaries, arising ca. 1 mm above the base of the head.	Outer phyllaries free from inner phyllaries, arising at the base of the head.

Coreopsis verticillata (Fig. 33) includes two chromosomal races, $n = 13$ and $n = 26$. The tetraploid race appears to be an autotetraploid of the diploid race, since the two are not morphologically distinguishable with any level of confidence, and appears to be limited to southeastern Virginia and northeastern North Carolina (Radford *et al.*, 1974). I have made chromosome counts from a few populations of *C. verticillata;* these few counts agree with the distribution presented by Radford *et al.* 1974): $n = 13$—N.C., Stanley Co., *E. B. Smith 1704;* Montgomery Co., *E. B. Smith 1706.* $n = 26$—N.C., Hertford Co., *E. B. Smith 1810;* Martin Co., *E. B. Smith 1811.*

This species was evidently involved in the parentage of *C.* ×*delphinifolia* (see that species).

Attempted hybridizations of the diploid race ($n = 13$) of *C. verticillata* with *C. falcata, C. major* f. *major, C.* ×*delphinifolia,* and *C. palmata* all failed.

Successful hybridizations included:

C. verticillata ($n = 13$) × *C. tripteris.* This hybridization was successful with *C. verticillata* as the male parent; see *C. tripteris* for details.

C. verticillata ($n=13$) × *C. pulchra.* Only five F_1 hybrids of this combination were obtained. They resembled *C. verticillata* but had apically reddish-brown disk flowers. They averaged 68% pollen stainability, and one

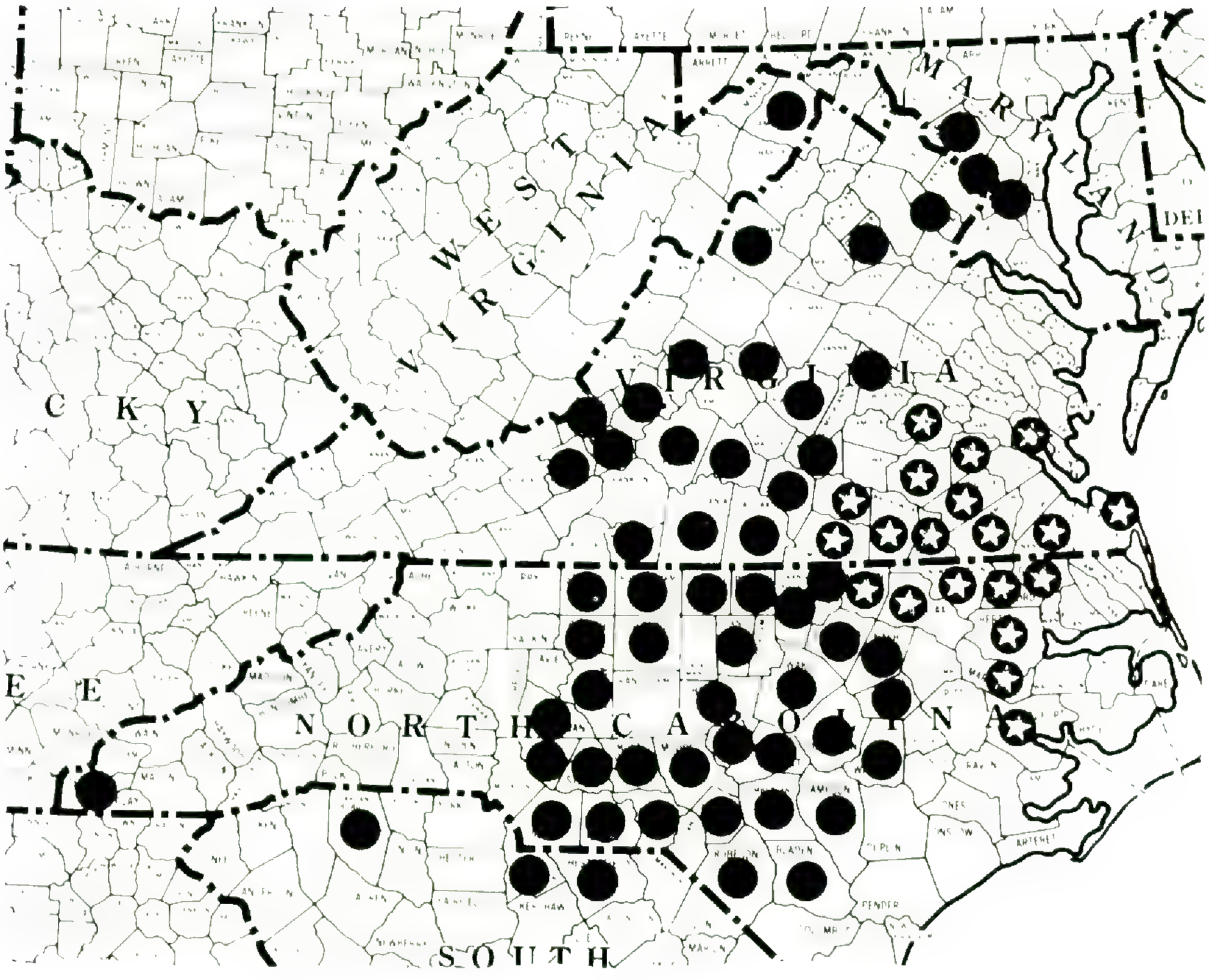

Fig. 32. Distribution of *C. verticillata*. dots = diploid ($n = 13$) race; white star in black circle = tetraploid ($n = 26$), based largely on Radford *et al* (1974).

analyzed meiotically had $n = 13$ at diakinesis. There is evidently little structural difference in the chromosomes of the two species. Attempts were made to produce both an F_2 and BC_1 generation of this cross. Only two F_2 achenes were produced, and the two seedlings from the achenes died in the seedling stage. Only three BC_1 progeny (*C. verticillata* the repeating parent) were obtained. All three retained the apically reddish-brown disk corolla character of *C. pulchra;* their average pollen stainability was 83%. While there appears to be little difference between *C. verticillata* ($n = 13$) and *C. pulchra* chromosomally, there are indications in these results that the two differ genetically to an extent that early death of embryos and inviability occurs in the F_2 generation.

I have only recently obtained breeding material of the tetraploid race ($n = 26$) of *C. verticillata* and have not yet attempted hybridizations with it.

IV. Section EUBLEPHARIS Nutt., Trans. Amer. Philos. Soc. II. 7:359. 1841.
Sect. *Rabdocaulis* Nutt., Trans. Amer. Philos. Soc. II. 7:359. 1841.

Fig. 33. *Coreopsis verticillata*; achene at upper right.

Sect. *Calliopsis* (Reichenb.) Nutt. (in part: *C. rosea*), Trans. Amer. Philos. Soc. II. 7:360. 1841.

Sect. *Coreoloma* T. & G. (excl. *C. leavenworthii*), Fl. N. Amer. 2:346. 1842.

Sect. *Cosmella* T. & G., Fl. N. Amer. 2:348. 1842.

Subg. *Calliopsis* F. Boynton (in part) *in* Small, Man. SE. Fl. 1446. 1933.

Sect. *Tinctoriae* F. Boynton (in part: *C. rosea*) *in* Small, Man. SE. Fl. 1446. 1933.

Sect. *Nudatae* F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Sect. *Angustifoliae* F. Boynton (in part) *in* Small, Man. SE. Fl. 1446. 1933.

Herbaceous perennials, from rhizomes or corm-like bases; leaves commonly alternate, sometimes opposite, simple, entire or auricled; outer phyllaries often irregularly placed; ray flowers 5-8, entirely orangish-yellow (infrequently with a tiny reddish-brown spot at the base of the ligule) or rosaceous (and then becoming wine-purple or whitish with age), the ligule cuneate-obovate and 3-lobed apically; disk flowers ca. 60-120, the corolla ca. 2-4.8 mm long, yellow or apically deep wine-purple, 4-toothed apically, with 4 anthers, the style tips more or less truncate in outline; palea narrowly to broadly linear, acute to rounded apically, glabrous, deciduous; achenes obcompressed, ca. 2-4.5 mm long, with pectinate wings (absent in one species), glabrous to papillate, bald at the apex or (commonly) biaristate, with aristae ca. 0.2-2.5 mm long and minutely antrorsely hispid. $x = 13$.

17. C. ROSEA Nutt., Gen. 2:179. 1818.

Calliopsis rosea Spreng., Syst. 3:611. 1826.

Coreopsis rosea Nutt. forma *leucantha* Fern., Rhodora 21:171. 1919.

TYPE: United States: New Jersey: *Nuttall s.n.* (LECTOTYPE BM!).

Blooming: late Jul-mid Sep. Habitat: Sandy or rocky margins of lakes and ponds. Chromosome number: $n = 13$.

Sherff (1936, 1955) included Virginia to Georgia in the range of *C. rosea*, on the basis of Nuttall's range statement "from New Jersey to Georgia" (Nuttall, 1818). The actual range (Fig. 34) is from Nova Scotia (not shown in Fig. 34) to Maryland.

Coreopsis rosea (Fig. 35) was treated in section *Calliopsis* by Sherff (1936, 1955), and was left there as somewhat unusual for the section by Parker (1973). It is better treated in section *Eublepharis*, however (Smith, 1975), because of its closer affinity to species in this section.

Attempted hybridizations of *C. rosea* with *C. basalis*, *C. wrightii*, *C. nudata*, *C. linifolia* ($n = 13$ & 26), *C. tinctoria* var. *tinctoria*, *C. tinctoria* var. *similis*, *C. leavenworthii*, *C. major* f. *oemleri* ($n = 39$), *C. tripteris*, *C. grandiflora* var. *grandiflora*, *C. grandiflora* var. *harveyana* "heterolepis" phase, *C. intermedia*, and *C. nuecensoides* all failed.

Only two hybridizations with *C. rosea* were successful:

C. rosea × *C. gladiata*. Ten F_1 plants of this combination were obtained;

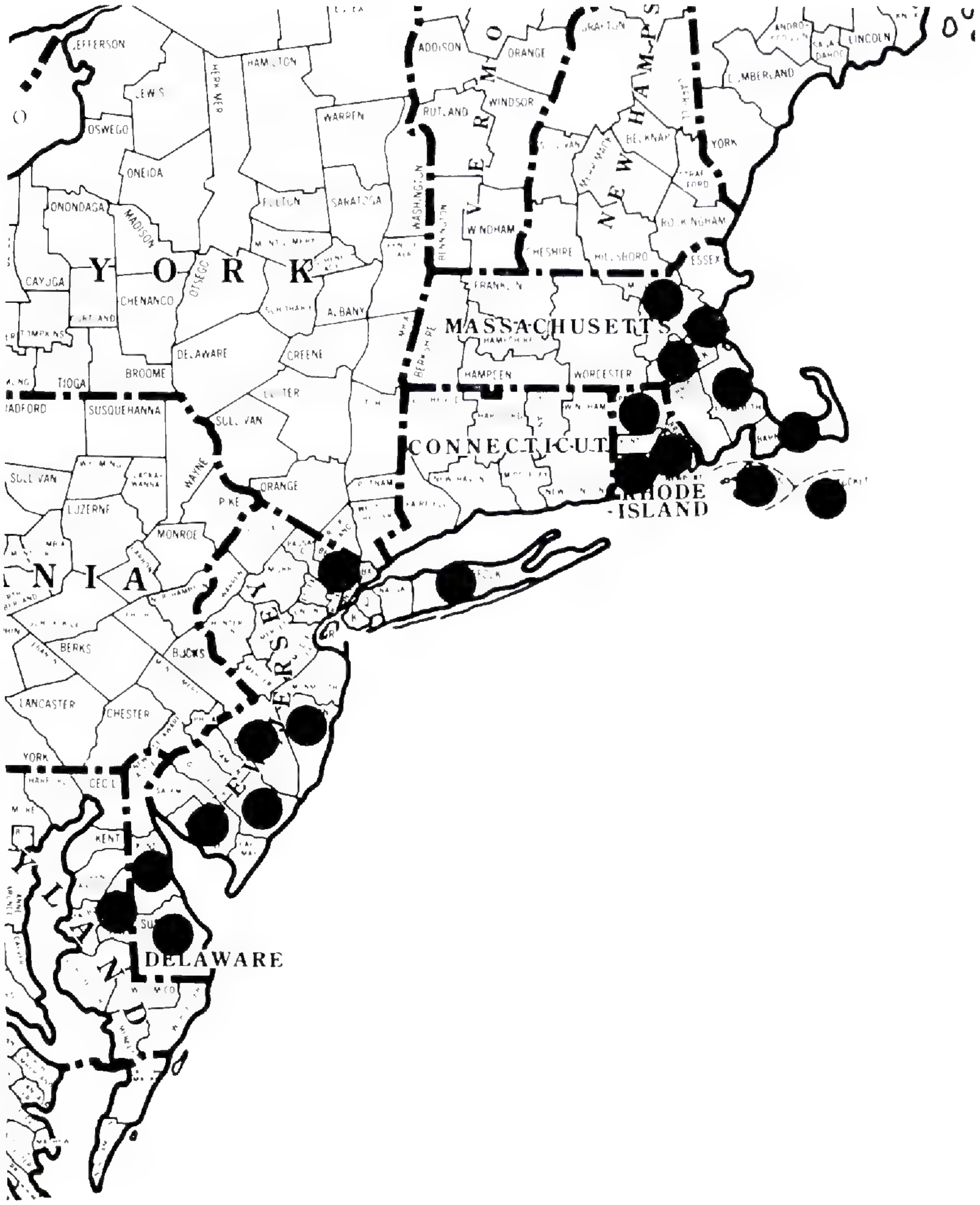

Fig. 34. Distribution of *C. rosea* (also occurs in Nova Scotia).

they averaged 4% pollen stainability. The hybrids had narrowly oblanceolate mostly opposite (some alternate) leaves. The fresh ligules of the hybrids were pale lemon-yellow and faded to whitish (tinged with yellow) with age; the disk flowers were apically brownish. The immature ovaries bore short antrorsely setulose aristae and a narrow fringe of setae on the margins. Although many heads of the F_1 hybrids were open pollinated and intercrossed, no fruit set occurred and no F_2 was obtained.

C. rosea × *C. nudata*. See the latter species for details of this hybridization.

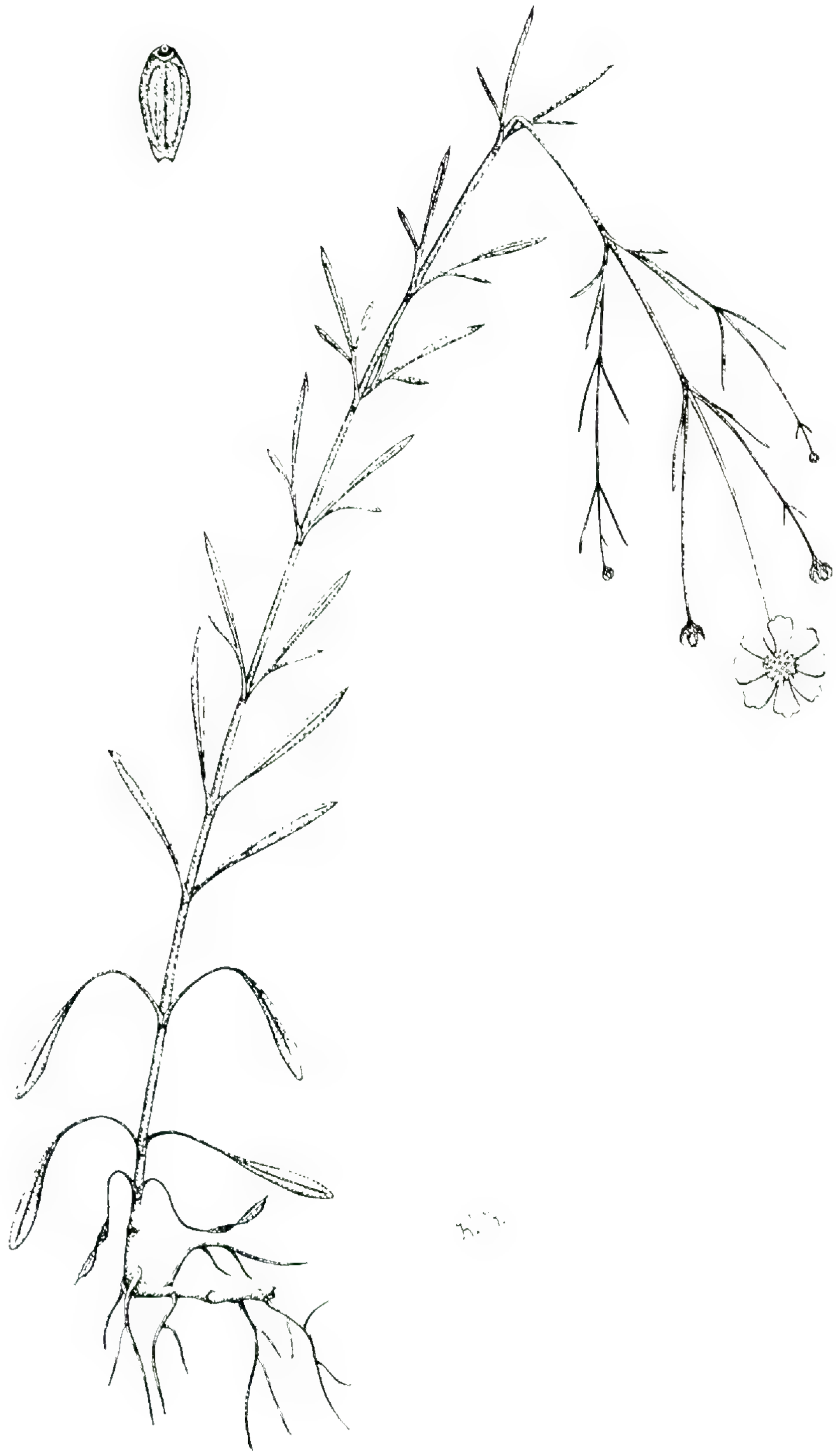

Fig. 35. *Coreopsis rosea;* achene at upper left.

18. C. NUDATA Nutt., Gen. 2:180. 1818.

Calliopsis nudata Spreng., Syst. 3:611. 1826.

TYPE: United States: Florida: near St. Mary's, west Florida. *William Baldwin s.n.* (Herbarium?).

Blooming: Apr-May. Habitat: Wet sandy ditches, margins of ponds and swamps. Chromosome number: $n = 13$ (+ 0-2 B).

I have not seen type material of *C. nudata.* This is a very distinctive species (Fig. 36; Fig. 37), with juncoid leaves (young leaves on seedlings and smaller plants bear an expanded obovate blade-like portion at the apex of the elongated petioles), pale purple to pink ligules, and yellow disk flowers. An excellent illustration occurs in *Botanical Magazine* (*pl.* 6419, 1879).

Attempted hybridizations of *C. nudata* with *C. intermedia, C. grandiflora* var. *harveyana, C. grandiflora* var. *longipes, C. grandiflora* var. *saxicola* (Arkansas material), *C. nuecensoides, C. basalis, C. lanceolata, C. linifolia* ($n = 13$), *C. gladiata, C. falcata,* and *C. tinctoria* var. *tinctoria* all failed.

One hybridization with *C. nudata* was slightly successful: *C. nudata* × *C. rosea.* Two rather sickly seedlings were obtained from this cross. One died, but one, after remaining vegetative for more than a year, has finally flowered. The leaves are similar to those of *C. rosea* but larger and the petioles tend to be elongated; the flowers are intermediate in size with pale purple ligules. The plant exhibited 3% pollen stainability.

19. C. LINIFOLIA Nutt., Jour. Acad. Nat. Sci. Philadelphia 7:75. 1834.

Coreopsis callosa Bertol., Novi Comm. Bonon. 9:224. 1848.

Coreopsis oniscicarpa Fern., Rhodora 40:472. 1938.

Coreopsis oniscicarpa Fern. var. *simulans* Fern., Rhodora 44:476. 1942.

Coreopsis gladiata Walt. var. *linifolia* (Nutt.) Cronq., Rhodora 47:396. 1945.

Coreopsis saxicoloidea Sherff, Brittonia 14:172. 1962.

TYPE: United States: Alabama: *D. Gaeb?* (name illegible) *s.n* (HOLOTYPE BM!).

Blooming: late Aug-Oct. Habitat: Wet, grassy, sandy ditches; savannas and pine barrens, margins of bogs and ponds. Chromosome number: $n = 13, 26$ (two races).

Two chromosome races of *C. linifolia* (Fig. 38) exist, not differing sufficiently morphologically to justify nomenclatural recognition. Chromosome counts thus far are known for only 13 populations, but the two races appear to be divided into a Gulf Coast diploid race (Fig. 39, white stars in black circles) and an Atlantic Coast tetraploid race (Fig. 39, dots). Chromosome counts from populations in Hardin Co., Texas; St. Tammany Parish, Louisiana; Stone and Jackson counties, Mississippi; and Santa Rosa, Walton, Bay, and Gulf counties, Florida, were all $n = 13$ (one plant $n = 13 + 1$ B). Chromosome counts from Georgetown and Berkeley counties, South Carolina; and Bulloch, Irwin, and Ware counties, Georgia, were all $n = 26$ (or ca.

Fig. 36. *Coreopsis nudata;* achene at upper left.

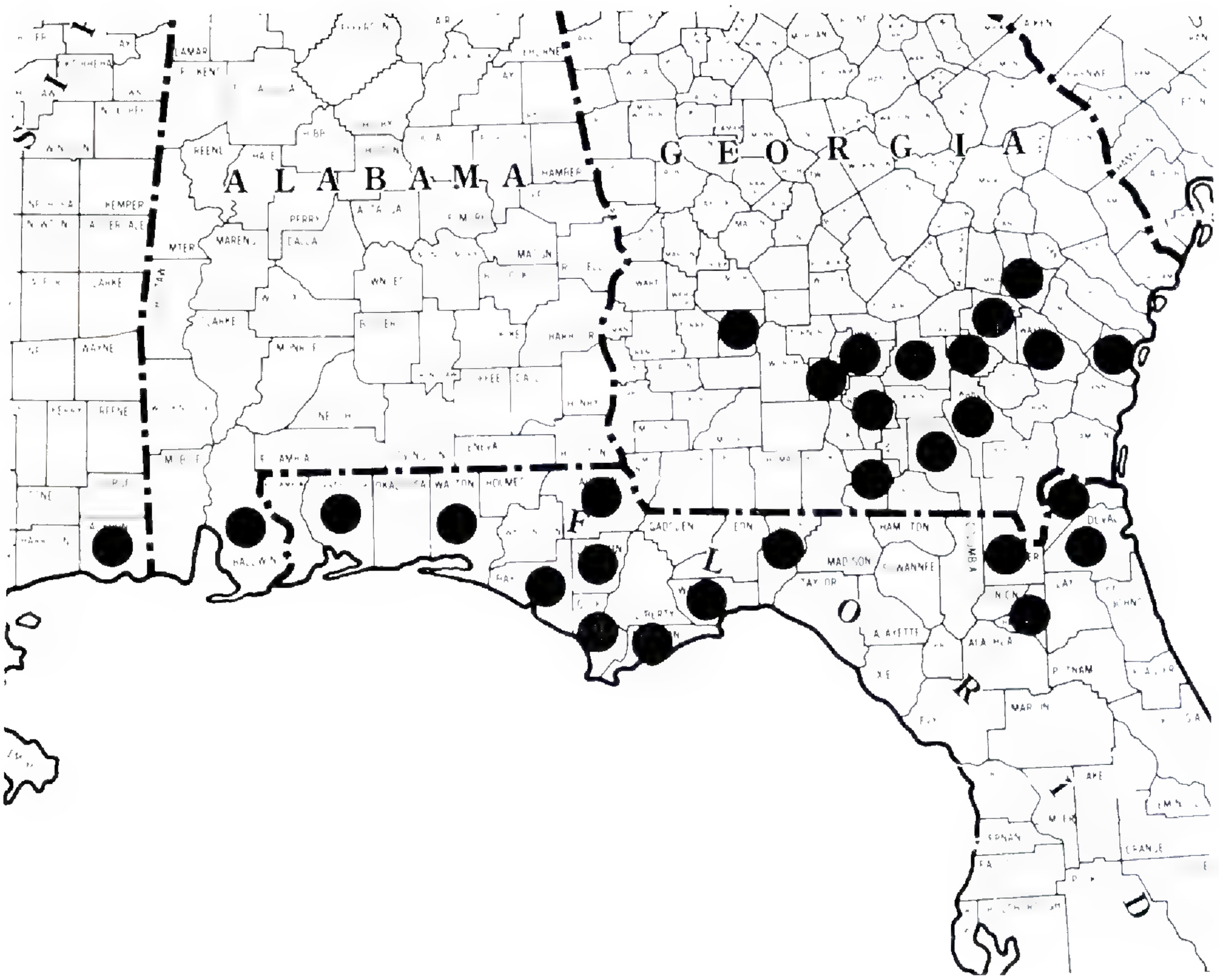

Fig. 37. Distribution of *C. nudata.*

26). The distribution of the two types shown in Fig. 39 is tentative.

The close morphological similarity of the two races suggests that the tetraploid race is an autotetraploid derivative of the diploid race. It seems possible that it is an allotetraploid, derived from hybridization between the diploid race and *C. gladiata* followed by doubling of the chromosome number. But, in one-dimensional paper chromatography of leaf extracts of the $n = 13$ & $n = 26$ races of *C. linifolia* and of *C. gladiata* (performed by B. L. Lipscomb as a special problem), identical components were found for the $n = 13$ and $n = 26$ races of *C. linifolia* and both differed in two or three components from *C. gladiata.*

Fernald (1938, 1942) described *C. oniscicarpa* and *C. oniscicarpa* var. *simulans* on the basis of material of the tetraploid race of *C. linifolia* from Virginia. It is interesting that he noticed the slightly different aspect of the tetraploid race; however, the diploid and tetraploid races overlap in all morphological traits and he is hence unconvincing in the proposal of *C. oniscicarpa* as a new species. I have not seen the type material of *C. oniscicarpa* but have studied several sheets annotated with the name by Fernald.

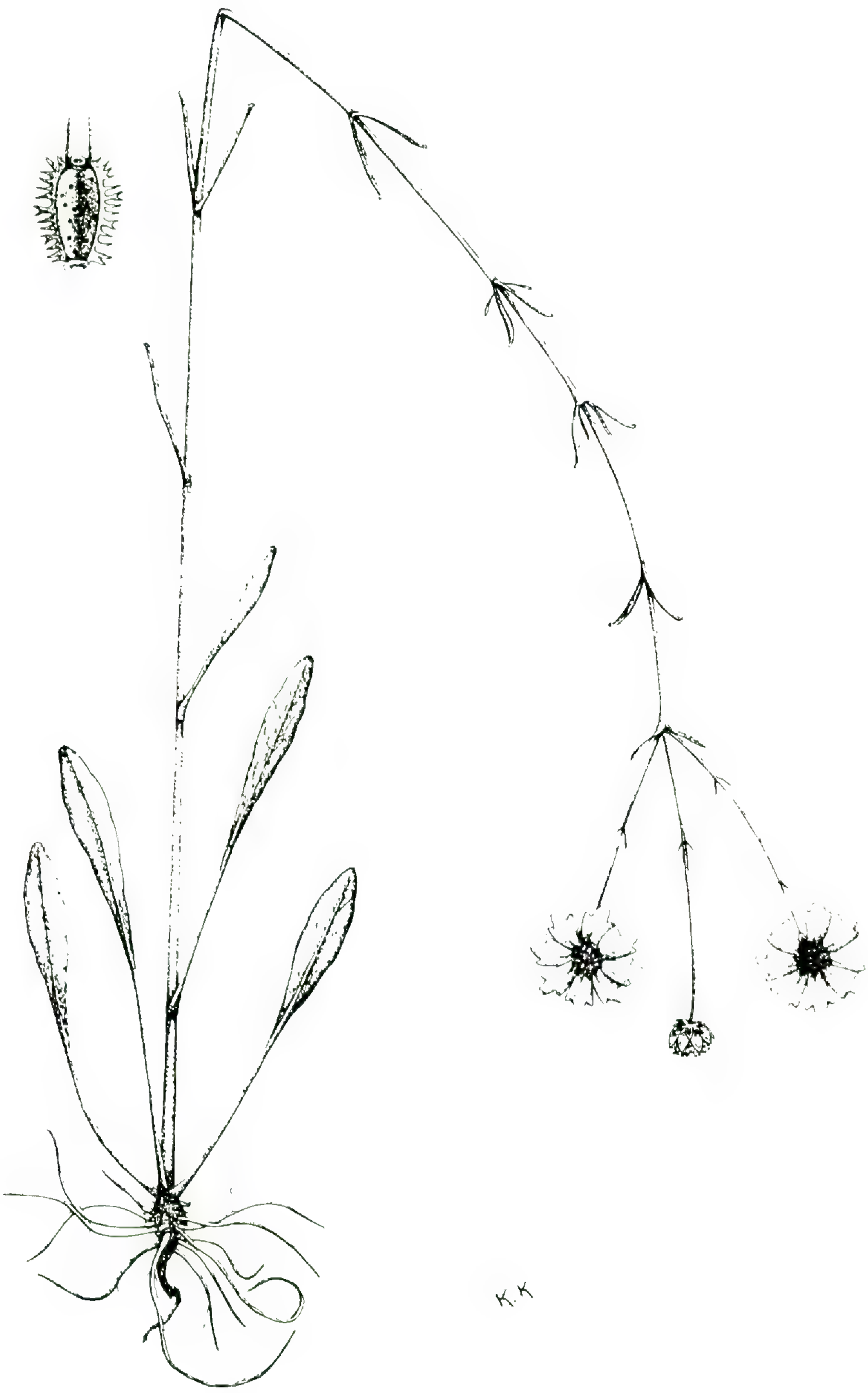

Fig. 38. *Coreopsis linifolia;* achene at upper left.

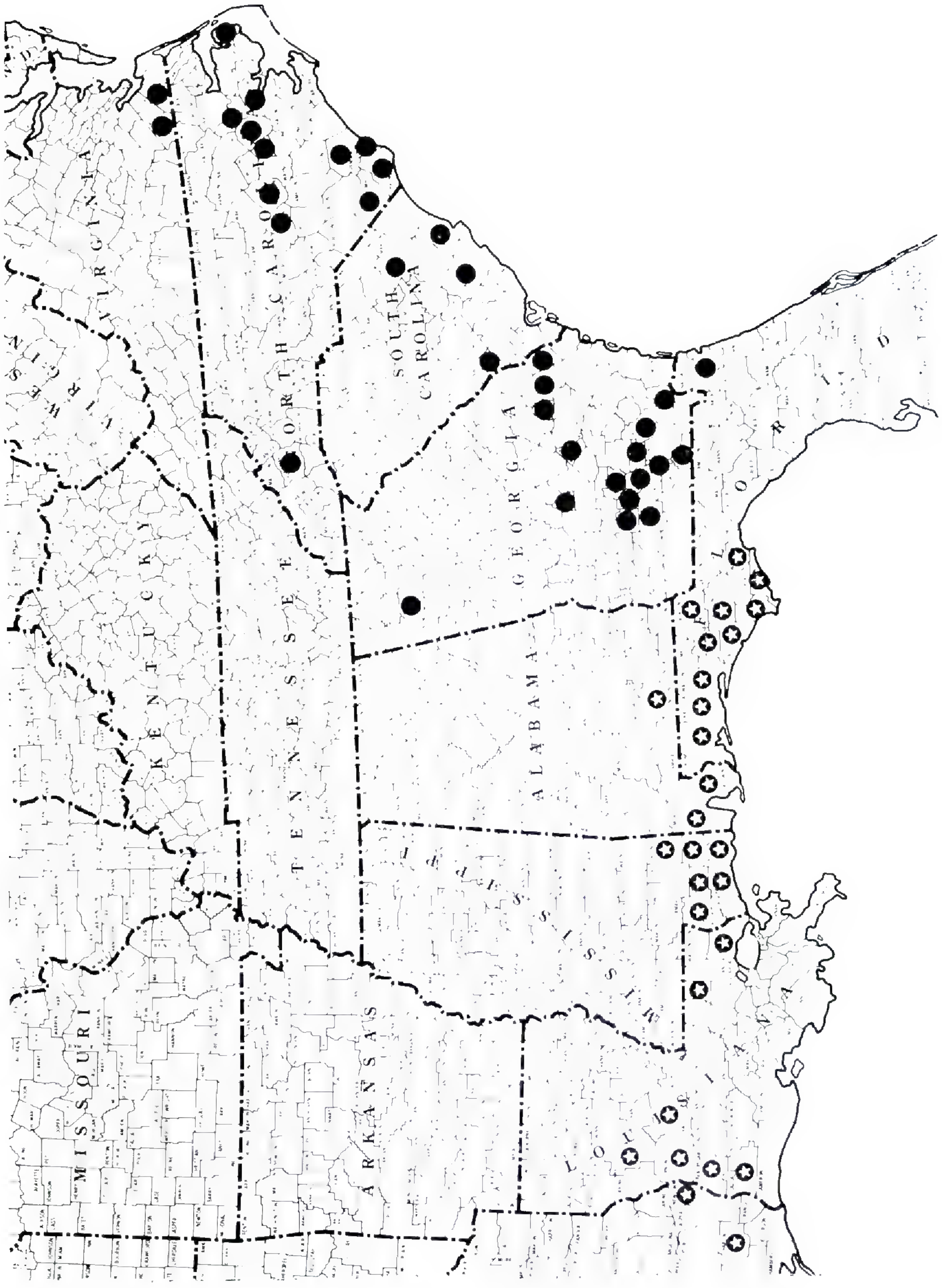

Fig. 39. Distribution of *C. linifolia*.
white star in black circle = diploid ($n = 13$) Gulf Coast race;
dots = tetraploid ($n = 26$) Atlantic Coast race.

Attempted hybridizations of the diploid race of *C. linifolia* ($n = 13$) with *C. basalis, C. intermedia, C. rosea, C. linifolia* ($n = 26$), *C. tinctoria* var. *tinctoria, C. nudata, C. floridana, C. major* f. *major,* and *C. latifolia* all failed.

Successful hybridizations with the diploid race included:

C. linifolia ($n = 13$) $\times$ *C. gladiata.* This hybridization succeeded with *C. linifolia* as the male parent; see *C. gladiata* for details.

C. linifolia ($n = 13$) $\times$ *C. saxicoloidea.* Eleven F_1 hybrids of this combination were obtained; 10 of these averaged 94% pollen stainability. *Coreopsis saxicoloidea* was established (Sherff, 1962) on the basis of its strictly opposite leaves and square stem and was erroneously assumed to be close to *C. grandiflora* var. *saxicola* (treated by Sherff as *C. saxicola*). It is, of course, most closely related to *C. linifolia* and should be merged with the latter species in my opinion. Individuals of *C. linifolia* can have all of the leaves opposite or the lowest one to several leaves alternate or all of the leaves alternate. The occurrence of opposite versus alternate leaves is correlated with quadrangular versus terete stem, so that plants with opposite leaves have quadrangular stems and those with alternate leaves have terete stems. Individuals bearing alternate leaves basally and opposite leaves above have the stem terete below and quadrangular above.

Attempted hybridizations of the tetraploid race of *Coreopsis linifolia* ($n = 26$) with *C. linifolia* ($n = 13$), *C. gladiata, C. saxicoloidea, C. floridana, C. rosea, C. tinctoria* var. *tinctoria, C. leavenworthii,* and *C. major* f. *oemleri* ($n = 13$) all failed.

20. COREOPSIS **floridana** E. B. Smith, sp. nov.

Herba perennis, erecta, ca. 0.3-1.0 m alta. Radix sub-cormosis, radicibus aliquot tenuibus; caulis teres. Folia glabra, maxime coriacea; inferiora magnum, petiolis 5-17(-22) cm longis, laminis 4-15 cm longis et 0.4-3.2 cm latis, late oblongis vel ellipticis, apexibus rotundatis; media et supra alterna (supra interdum opposita), redacta, linearis. Capitula pedunculis elongatis, pauca, magna, plerumque 4-6(-8.3!) cm lata a apicibus ligularum ad apicibus ligularum oppositarum. Phyllaria biserialia; exteriora 5-8, deltata, 2.5-5 mm longa et 2-4.6 mm lata, 0.6-1.2 lata quam longa, 0.2-0.4 longa quam interiora; interiora 8, late oblonga vel elliptica, 9-15 mm longa et 3.5-7 mm lata. Flosculi radii 8, steriles; corollae flavae; ligulis obdeltatis, ad apices trilobates. Flosculi disci multi; ad apices quadridentates et purpureo-brunneos; antheris quatour; style cum stigmatibus truncatibus; paleae lineares, deciduae. Achenia oblonga; corpibus 3.3-4.5 mm longibus et 1.1-2 mm latibus; alis pectinatis, 0.5-1 mm latis; aristis setulosis, 0.6-2.5 mm longis. Chromosomatum numerus: $n =$ ca. 78 (duodecaploideus).

TYPE: United States: Florida: Dixie Co., Common in low wet sandy ditch by US Alt. 27, 11.4 mi. NW of Shamrock, *E. B. Smith 1840,* 31 Oct 1974 (HOLOTYPE US! ISOTYPE FSU! UARK!, two sheets).

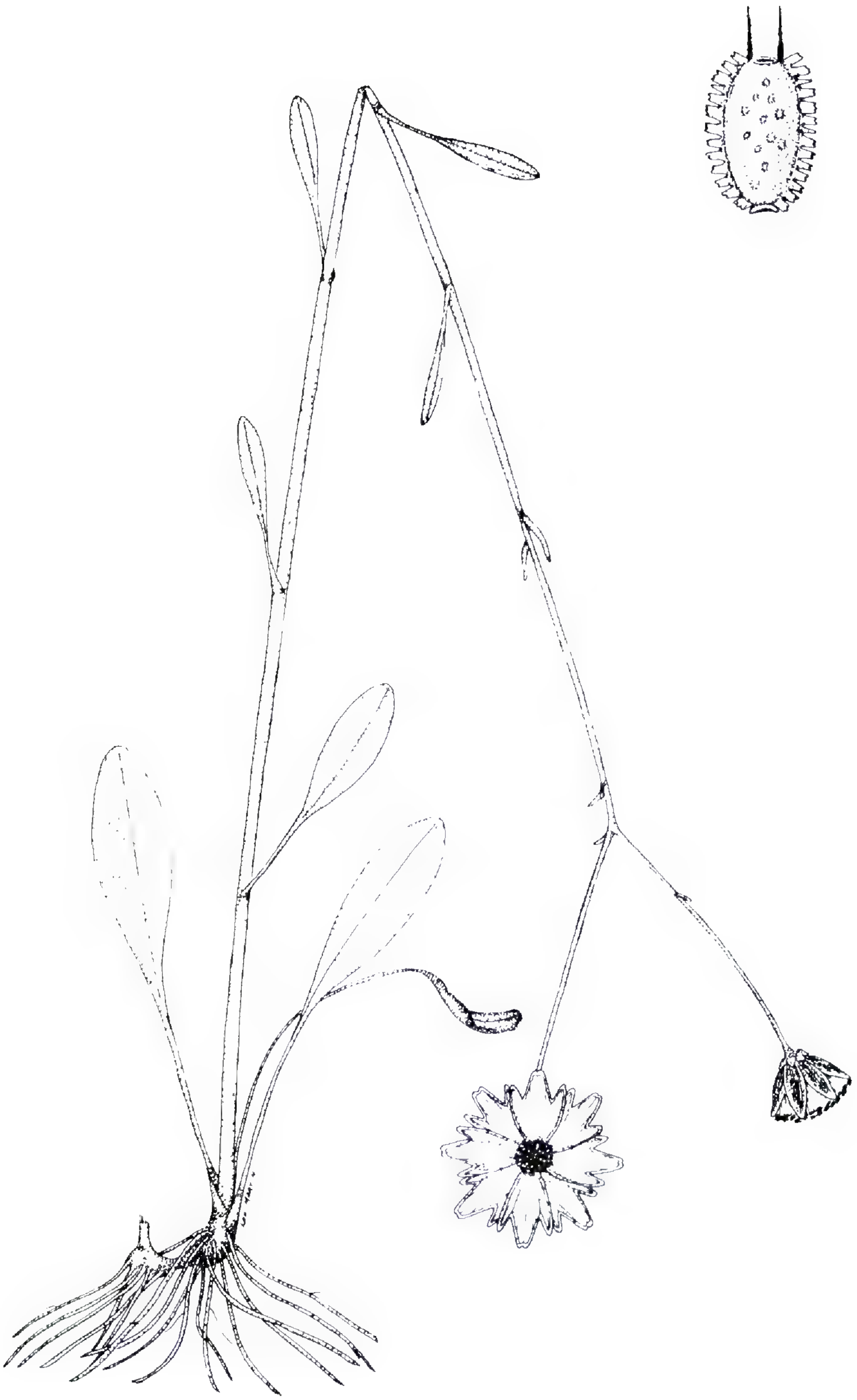

Fig. 40. *Coreopsis floridana;* achene at upper right.

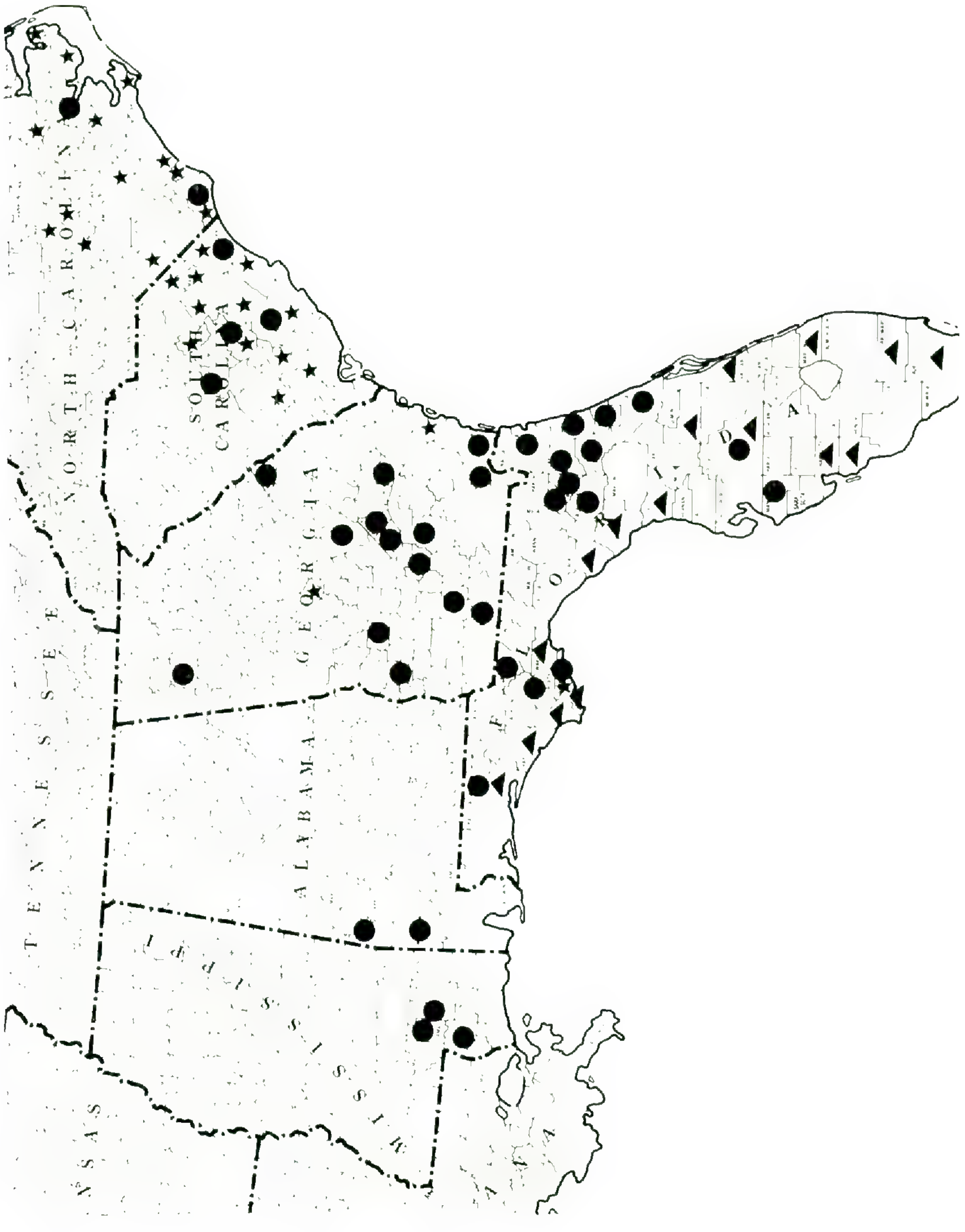

Fig. 41. Distribution of *C. floridana*, *C. gladiata*, and *C. falcata*.
triangles = *C. floridana;*
dots = *C. gladiata;*
stars = *C. falcata.*

Blooming: mid Oct-Dec(Feb). Habitat: Low sandy bogs and ditches, pine barrens, everglades. Chromosome number: n = ca. 78.

This species (Fig. 40), endemic to Florida (Fig. 41, triangles), is rather easily distinguished from *C. gladiata* by its deltoid outer phyllaries that are very much shorter than the inner (*C. gladiata* has lanceolate outer phyllaries that are often 1/3 to 2/3 as long as the inner), its glabrous leaves (*C. gladiata* leaves are often pubescent), larger heads, and mostly broader achene wings. It is easily distinguishable from *C. linifolia* in lack of clear-cut tiny dark dots on the leaves (present in *C. linifolia*) and in its much larger heads and mostly broader achene wings. *Coreopsis floridana* typically has large basal leaves, one fairly large leaf on the lowest cauline node, and the leaves above rapidly reduced to narrow bracts. Individuals blooming late in the season (late Dec-Feb) however, are often nearly scapose. The species probably represents a high polyploid (duodecaploid) derived from hybridization between *C. linifolia* and *C. gladiata* (or possibly *C. falcata*).

I have only recently obtained living material of *C. floridana* and have thus far attempted only a few hybridizations with it: *C. floridana* × *C. linifolia* (n = 13), *C. linifolia* (n = 26), and *C. gladiata* all failed.

21. C. GLADIATA Walt., Fl. Car. 215. 1788.

Coreopsis angustifolia Solander *in* Ait., Hort. Kew. 3:253. 1789 (not *C. angustifolia* L. 1753 nor *C. angustifolia* Pav. *ex* DC. 1823). The correct author citation for this homonym is Solander *in* Ait., according to Miss P. I. Edwards (Librarian, British Museum) who kindly sent me a Xerox copy of Solander's original description; *not* Ait. as listed in Small (1903, 1933) and Radford *et al.* (1968) *nor* Dryander *in* Ait. as listed by Sherff (1936, 1955). A specimen labeled "type" is still extant at BM.

Coreopsis dichotoma Michx., Fl. Bor.-Am. 2:137. 1803.

Coreopsis helianthoides Beadle, Bot. Gaz. 25:448. 1898 (not *C. helianthoides* Forst. 1786). Type: United States: Florida: Gadsden Co., Aspalaga, *A. W. Chapman s.n.*, Oct 1897 (Holotype probably in Biltmore Herbarium; probably destroyed). The Chapman specimen *2066*[c] in NY, referred to by Sherff (1936) is *C. floridana.*

Coreopsis longifolia Small, Bull. Torrey Bot. Club 22:47. 1895. Type: United States: Florida: Duval Co., In dry grassy pine woods about Jacksonville, *A. H. Curtiss 4489*, 16 Oct 1893 (HOLOTYPE NY! ISOTYPE NY!).

Coreopsis longifolia Small var. *godfreyi* Sherff, Bot. Leafl. 6:3 1952. Type: United States: Georgia: Wheeler Co., Boggy sphagnous depression in sandhills, 7 mi. S of McRae, *R. K. Godfrey 50793*, 14 Oct 1950 HOLOTYPE GA!).

TYPE: None cited. The plant in mind is understood to be a native of

"Carolina." I am here designating the following neotype: United States: South Carolina: Georgetown Co., Grass-sedge bog or savannah, 12 mi. N of Georgetown, *R. K. Godfrey 8238,* 15 Sep 1939 (NEOTYPE F! ISONEOTYPE TENN!).

Blooming: Sep-Nov. Habitat: Low, wet, sandy, grass-sedge bogs and ditches, swampy woods, moist pine barrens, margins of swamps. Chromosome number: $n = 13$ (+ 0-3 B).

This species (Fig. 42; Fig. 41, dots) is rather variable in leaf shape and pubescence, the leaves varying from orbicular-oblong to narrowly linear-elliptic and from glabrous to densely pubescent. The type material was described as glabrous. Most of the essentially glabrous specimens that I have observed from North and South Carolina have slightly to definitely ciliolate leaf margins (suggesting perhaps some possible contamination with *C. integrifolia*) while material from the remainder of the range characteristically has callus-margined leaves lacking ciliolation.

Pubescent individuals of *C. gladiata* have been described as *C. helianthoides* Beadle, a homonymn of *C. helianthoides* Forst. Narrow-leaved individuals were described as *C. longifolia* Small with a variety *godfreyi* erected by Sherff (1952) to accommodate narrow-leaved pubescent individuals. There is considerable variation in degree of pubescence, however, in field-collected material of *C. gladiata*—from densely pubescent-leaved individuals with rather pubescent stems through moderately pubescent-leaved glabrous-stemmed individuals to completely or essentially completely glabrous individuals. I have observed various degrees of pubescence in different individuals from the same populations in Florida and Georgia, and leaf shape and size similarly varies within populations. I do not believe that the variation in leaf shape, size, and pubescence merit taxonomic recognition, since intergradation occurs in all three characters.

The previous authority on *Coreopsis* (Sherff, 1936, 1955) often included individuals of *C. linifolia* within "*C. longifolia*" (as indicated by his annotation labels on herbarium material) and did not recognize the presence of *C. floridana;* material of *C. floridana* has been annotated by Sherff as *C. gladiata, C. longifolia,* and *C. helianthoides* (despite its lack of pubescence). Sherff (1936) called the Chapman specimen 2066[c], which is clearly *C. floridana,* "undoubtedly cotype material" of *C. helianthoides,* even though the Chapman specimen was glabrous and came from a different locality (Franklin Co., Apalachicola versus Gadsden Co., Aspalaga for *C. helianthoides*). I could not locate Aspalaga on present-day roadmaps, but it is or was (Thomas & Baldwin, 1859) about 45 mi NW of Tallahassee, which would place it near the present-day Sneads. This is about 50 miles from the nearest known location of *C. floridana.*

The ligules of *C. gladiata* sometimes bear a tiny reddish-brown spot at the base. I have observed individuals with such ligule spots in populations in Duval and St. John's counties in Florida and in Camden, Irwin, and

Fig. 42. *Coreopsis gladiata;* achene at upper left. The phase with leaves linear-elliptic (lower leaves absent at flowering time) is indicated at the right.

Telfair counties in Georgia. The ligule spot is variable within populations and variable with time in individuals. Some indivduals transplanted to the greenhouse bore the spot on earlier heads but lacked it on later heads. This is similar to the variation in ligule spotting in *C. basalis* (Smith, 1974).

Attempted hybridizations of *C. gladiata* with *C. pubescens* var. *pubescens*, *C. intermedia*, *C. nuecensoides*, *C. basalis*, *C. wrightii*, *C. linifolia* ($n = 26$), *C. nudata*, *C. floridana*, *C. major* f. *oemleri* ($n = 39$), *C. major* f. *oemleri* ($n = 13$), and *C. leavenworthii* all failed.

Successful hybridizations included:

C. gladiata × "*C. helianthoides*." Thirteen F_1 hybrids were obtained in this cross; eight had sparsely pubescent leaves and five had glabrous leaves. Eleven of the hybrids averaged 86% pollen stainability. Two of the sparsely pubescent hybrids were interbred to produce an F_2. Fourteen F_2 plants from this cross were all pubescent. These results suggest that leaf pubescence in *C. gladiata* is controlled by a recessive gene, the glabrous condition being dominant (and the *C. gladiata* parent in this cross was heterozygous). Due to the various degrees of pubescence in *C. gladiata*, however, it seems likely that one or more additional genes may be involved in pubescence of the species. Eleven of the F_2 plants averaged 87% pollen stainability. The high pollen stainabilities and good vigor of the F_1 and F_2 generations of this cross indicate that "*C. helianthoides*" is highly interfertile with *C. gladiata* and should be merged with it.

C. gladiata × *C. falcata*. This cross was successful with *C. gladiata* as the pollen parent. See *C. falcata* for details.

C. gladiata × "*C saxicoloidea*" (= diploid *C. linifolia*). After several unsuccessful attempts to hybridize *C. gladiata* and *C. linifolia*, I obtained few (three) F_1 hybrids by using the opposite-leaved quadrangular-stemmed phase of *C. linifolia*, "*C. saxicoloidea*." The F_1 plants had mostly alternate leaves of intermediate size, and the leaves lacked the tiny black spots so characteristic of *C. linifolia*. Two of the F_1 plants averaged 81% pollen stainability. One of them, examined in pollen meiosis, exhibited $n = 13^{II}$ (20 cells) and $n = 11^{II}, 1^{IV}$ (7 cells) at diakinesis. A few F_2 achenes have been obtained, but have not yet been planted. The two parental species showed surprising compatibility, considering the fact that hybridization between them (in terms of fruit set per hybridization attempt) was low. They appear to differ chromosomally by only one reciprocal translocation. On the basis of the F_1 pollen stainability and chromosome pairing, one would be tempted to recognize *C. linifolia* as a variety of *C. gladiata*, as Cronquist (1945) has done. But the low success in hybridization, coupled with the apparently consistently different morphology in the field and the apparent lack of natural hybridization between the two makes me inclined to maintain the two at the species level.

C. gladiata × *C. rosea*. This cross was successful with *C. gladiata* as the pollen parent; see *C. rosea* for details.

C. gladiata × *C. tinctoria* var. *tinctoria*. This cross was successful with *C. gladiata* as the pollen parent and represents the only intersectional hybrid that I obtained; see *C. tinctoria* for details.

22. C. FALCATA F. Boynton, Biltmore Bot. Stud. 1:141. 1902.

TYPE: United States: North Carolina: Robeson Co., In shallow water near Pembroke, *Biltmore Herbarium s.n.*, Jun 1901 (HOLOTYPE Bilt., destroyed; ISOTYPE NY!).

Blooming: late May-Jun(Sep). Habitat: Low wet grass-sedge ditches and bogs, savannas, pine barrens. Chromosome number: $n = 13$.

This species (Fig. 43; Fig. 41, stars) is sometimes rather similar to *C. gladiata* and *C. linifolia* but is usually easily distinguishable by its different blooming period (it commonly blooms in the spring, rarely in September during the blooming periods of *C. gladiata* and *C. linifolia*), lack of tiny dark dots on the leaves, the general presence of auricles on one or more leaves, and the broad wings on the achenes. It is always glabrous (as is *C. linifolia*), in contrast to the frequent occurrence of pubescence on the leaves of *C. gladiata*. The leaves are often more or less falcate, but this character does not appear to be distinctive enough to be very useful in separating the species from *C. gladiata*.

Coreopsis falcata is moderately interfertile with *C. gladiata* in artificial crosses (see below) and a case could be made for its reduction to a variety of *C. gladiata*. But *C. falcata* is isolated temporally from *C. gladiata* and only rarely would have the opportunity for hybridization in nature. This fact and the moderate reduction in fertility in the artificial hybrids and the consistent differences in morphology of field-collected material make me inclined to maintain the two at the species level.

Attempted hybridizations of *C. falcata* with *C. grandiflora* var. *harveyana* "heterolepis" phase, *C. pubescens* var. *pubescens*, *C. nuecensoides*, *C. nudata*, *C. major* f. *oemleri* ($n = 39$), *C. verticillata* ($n = 13$), and *C. tinctoria* var. *tinctoria* all failed.

The only successful hybridizations involved *C. gladiata*:

C. falcata × *C. gladiata*. Twelve F_1 hybrids of this combination were obtained. They were vigorous and averaged 59% pollen stainability. Two of the F_1 were studied in pollen meiosis and exhibited $n = 13$ at diakinesis. The achene wings were intermediate in width. In the first year of growth, none of the F_1 had any auricled leaves. During the second year of growth, however, three of the 12 produced at least one auricled leaf. The presence of auricled leaves is apparently at least partly dependent on the age of the plant.

The F_1 hybrids were intercrossed and produced an F_2 generation with little difficulty. In the first year of growth, five of the 32 F_2 plants bore one or more auricled leaves. The achene wings ranged from very narrow (*C. gladiata*-like) to rather broad (*C. falca*ta-like), with no clear-cut sub-

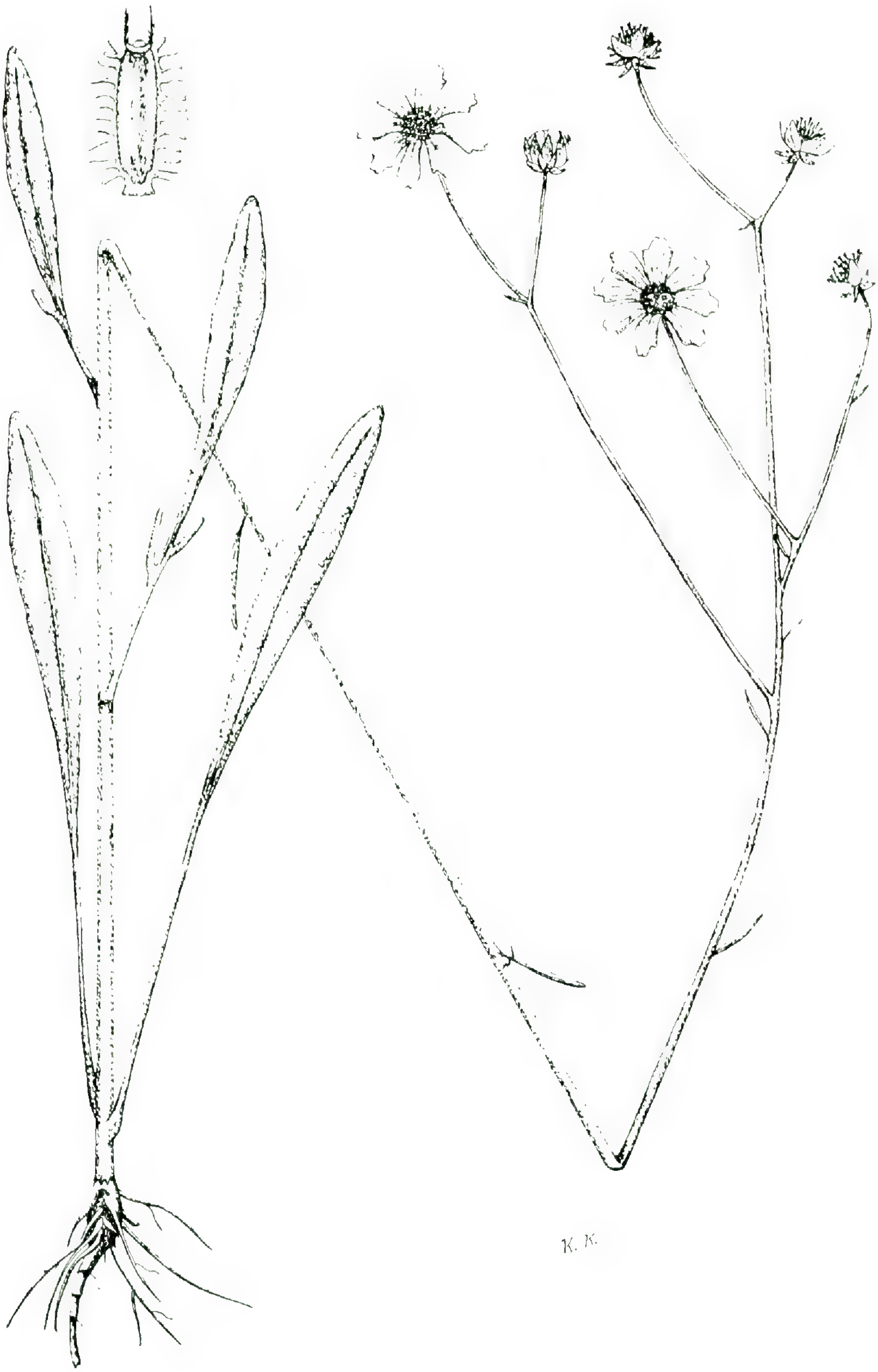

Fig. 43. *Coreopsis falcata;* achene at upper left.

division into classes. Twenty-seven of the F_2 plants averaged 70% pollen stainability. Due to space limitations, most of the F_2 were discarded at the end of the first growing season.

Some of the F_1 hybrids were back-crossed to the *C. gladiata* parent. Seventeen BC_1 hybrids were grown. None of these had any auricled leaves in the first year of growth. Sixteen of the BC_1 hybrids averaged 91% pollen stainability. The achene wings varied from narrow to intermediate in width, with no clear-cut segregation into classes. Most of the BC_1 plants were discarded at the end of the first growing season.

23. C. INTEGRIFOLIA Poir. *in* Lam., Encyc. Suppl. 2:353. 1811.

TYPE: United States: "Carolina", *Bosc s.n.*, (Herb. Mus. Paris No. 1044/74), (ISOTYPE P!).

Blooming: (Jul)Aug-Nov. Habitat: Moist sandy banks and low flat flood plains of rivers and creeks. Chromosome number: $n = 26$.

This species (Fig. 44; Fig. 45) is rarely collected; its fruiting characters were unknown as recently as 1955 (Sherff, 1955). I have collected the species along the Chipola River in Calhoun and Jackson counties, Florida, where it is rather common. Dr. Loran C. Anderson (Florida State University) has been kind enough to collect living material of it from near Ichawaynochaway Creek in Calhoun County, Georgia, for me; he reports that a large population of the species occurs there. The mature fruit of *C. integrifolia* is much like that of *C. gladiata*.

In general aspect, with its simple stem and entire leaves, the lower leaves petiolate and the upper sessile or subsessile, *C. integrifolia* mimics *C. intermedia* and *C. pubescens* var. *pubescens* of section *Coreopsis*. But its disk flowers are apically 4-toothed and its ligules are apically 3-lobed (disk flowers apically 5-toothed and ligules apically 4-5-toothed in *C. intermedia* and *C. pubescens* var. *pubescens*). Other characters, such as disk flower color and achene morphology, also differ between *C. integrifolia* and these species.

The pubescence of the flat portion of the blade in *C. integrifolia* is variable, from essentially glabrous to medium-densely pubescent. The Ichawaynochaway Creek population includes the entire spectrum of pubescence types. Most indivduals that I have observed have at least sparse pubescence on the flat portion of the blade. The petioles are ciliate and the leaf margins ciliolate.

I have only recently obtained living material of *C. integrifolia* and have not yet attempted hybridizations with it. Considering that *C. integrifolia* is tetraploid, it seems unlikely that it will hybridize very successfully with the diploids in section *Eublepharis*.

V. Section CALLIOPSIS (Reichenb.) Nutt. (excl. *C. rosea*), Trans. Amer. Philos. Soc. II. 7:360. 1841.

Calliopsis Reichenb., Ic. Pl. Cult. *pl.* 70, as genus. 1823.

Fig. 44. *Coreopsis integrifolia;* achene at upper left.

Fig. 45. Distribution of *C. integrifolia*.

Diplosastera Tausch, Hort. Canal. 15, as genus. 1823.

Sect. *Coreoloma* (in part: *C. leavenworthii*) and subsection *Calliopsidium* T. & G., Fl. N. Amer. 2:346. 1842.

Subg. *Calliopsis* and sects. *Tinctoriae* (in part: *C. tinctoria*) and *Angustifoliae* (in part) F. Boynton *in* Small, Man. SE. Fl. 1446. 1933.

Herbaceous tap-rooted annuals to herbaceous perennials; leaves opposite, simple and entire to auricled or (commonly) pinnately 1-2-compound; outer phyllaries often irregularly placed; ray flowers about 7 or 8, entirely orangish-yellow or bearing a small to large reddish-brown spot at the base of the ligule, the ligule cuneate-obovate and 3-lobed apically; disk flowers ca. 60-120, the corolla ca. 2-2.5 mm long, apically deep wine-purple, 4-toothed apically, with 4 anthers, the style tips more or less truncate in outline; palea narrowly linear, acute, glabrous, deciduous; achenes obcompressed, ca. 2-4 mm long, wingless or (commonly) winged, glabrous or minutely papillate, bald at the apex or biaristate with aristae 0.1-1.1 mm. long and glabrous to slightly antrorsely hispidulous. $x = 12$.

The above description includes only those taxa of the section present in the eastern U.S. and Canada. This section is closely related to section *Eublepharis* (Smith, 1975).

24. C. LEAVENWORTHII T. & G., Fl. N. Amer. 2:346. 1842.

Coreopsis leavenworthii T. & G. var. *garberi* A. Gray, Syn. Fl. N. Amer. I^2 :291. 1884.

Coreopsis lewtonii Small, Bull. Torr. Bot. Club 25:146 1898. Type: United States: Florida: Forrest City, *F. L. Lewton s.n.* 1894 (HOLOTYPE NY!).

Coreopsis angustata Greene, Pittonia 4:239. 1901.

Coreopsis leavenworthii T. & G. var. *curtissii* Sherff, Bot. Gaz. 94:592. 1933. Type: United States: Florida: In dry pastured ground along the Suwannee River, near Branford, *A. H. Curtiss 6734*, 23 Oct 1900 (HOLOTYPE GH!).

Coreopsis leavenworthii T. & G. var. *lewtonii* (Small) Sherff, Bot. Gaz. 94:592. 1933.

Coreopsis leavenworthii T. & G. var. *typica* Sherff, Brittonia 6:341. 1948.

TYPE: United States: Florida: Tampa Bay, *Leavenworth s.n.* (HOLOTYPE GH!).

Blooming: Apr-May (sporadically all year). Habitat: Low wet sandy flatwoods and savannas. Chromosome number: $n = 12$.

This species (Fig. 46), endemic to Florida (Fig. 47), superficially resembles *C. linifolia* but commonly has at least a few lower or submedian leaves either pinnately compound or with evident auricles (the leaves of *C. linifolia* are strictly entire). It leaves lack the tiny dark dots characteristic of *C. linifolia*. It might be confused with *C. tinctoria* but lacks a reddish-brown spot at the base of the ligules (generally present in *C. tinctoria*) and has broadly-winged achenes with aristae slightly antrorsely hispidulous (*C. tinctoria* has achenes wingless to medium-broadly winged, the aristae represented by two minute teeth or present and essentially glabrous).

There is considerable variation in leaf morphology in *C. leavenworthii* and several varieties have been proposed for various segregates. Parker (1973) has shown, however, that the "varieties" intergrade copiously, commonly occur intermixed in the same population, and do not breed true. Hybrids among them are highly fertile, indicating high interfertility among the segregates. In short, the "varieties" are mere populational variation and should be merged with the typical form.

Attempted hybridizations (conducted by Parker (1973) and me) of *C. leavenworthii* with *C. basalis*, *C. wrightii*, *C. grandiflora* var. *longipes*, *C. nuecensoides*, *C. linifolia* ($n = 26$), *C. rosea*, and *C. gladiata* all failed.

Hybridizations that succeeded (Parker, 1973) included:

C. leavenworthii × *C. tinctoria* var. *tinctoria*. Twenty-nine F_1 hybrids of this combination averaged 31% pollen stainability. At diakinesis of pollen meiosis, the most common configuration observed was $n = 7^{II}, 2^{III}, 1^{IV}$, indicating that the genomes of the two taxa differ by at least two reciprocal translocations.

Fig. 46. *Coreopsis leavenworthii;* achene at upper left.

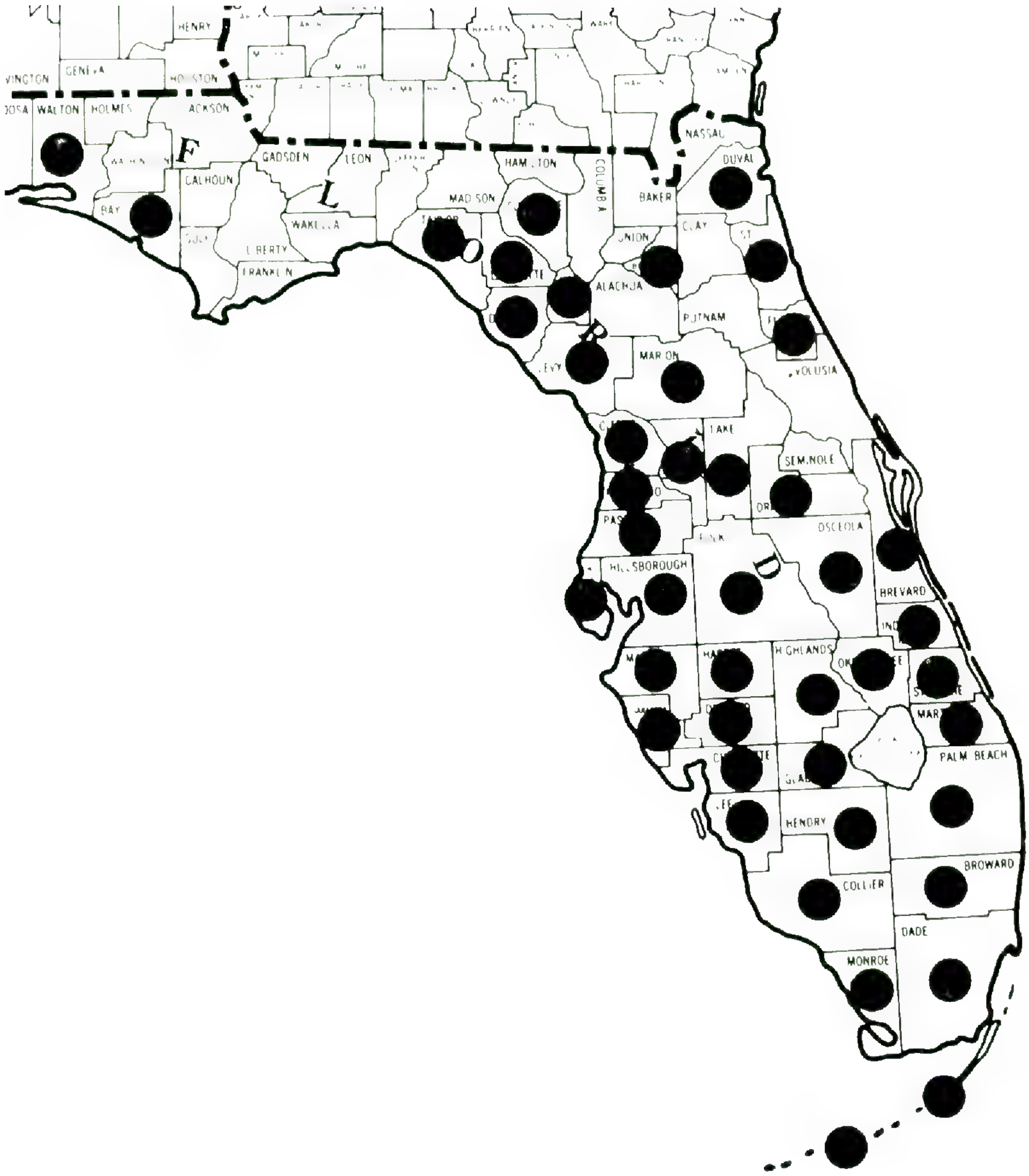

Fig. 47. Distribution of *C. leavenworthii*.

C. leavenworthii × *C. tinctoria* var. *similis*. Eleven F_1 hybrids of this combination averaged 13% pollen stainability. At diakinesis of pollen meiosis, the most common configuration observed was $n = 3^{I}, 9^{II}, 1^{III}$, indicating several structural differences in the genomes of the two taxa.

25a. C. TINCTORIA Nutt., Jour. Acad. Nat. Sci. Philadelphia 2:114. 1821, var. TINCTORIA

Diplosastera tinctoria (Nutt.) Tausch, Hortus Canal. 16 *pl.* 4. 1823.

Calliopsis bicolor H. G. L. Reichenb., Icon. Descript. Pl. Cult. 2: *pl.* 70. 1823.

Calliopsis tinctoria (Nutt.) DC., Prodr. 5:568. 1836.

Calliopsis tinctoria (Nutt.) DC. var. *atropurpurea* Hook., Bot. Mag. *pl.* 3511. 1836.

Calliopsis cardaminefolia DC., Prodr. 5:568. 1836. Type: United States: Texas: *Berlandier 566,* 15 May 1829 (HOLOTYPE GH!).

Coreopsis cardaminifolia (DC.) Nutt., Trans. Amer. Philos. Soc. II. 7:360. 1841. (orthographic variant).

Coreopsis cardaminefolia (DC.) Nutt. var. *lineariloba* A. Gray, Syn. Fl. N. Amer. I^2 :291. 1841.

Coreopsis cardaminefolia (DC.) Nutt. var. *angustiloba* T. & G., Fl. N. Amer. 2:346. 1842. Type: United States: Louisiana: *Dr. Hale s.n.* (HOLOTYPE PH!; ISOTYPE GH!).

Coreopsis stenophylla F. Boynton, Biltmore Bot. Stud. 1:141. 1902. Type: United States: Louisiana: Hammond, *Dr. Hale s.n.* (ISOTYPE NY!).

Coreopsis tinctoria Nutt. var. *imminuta* Sherff, Bot. Gaz. 94:594. 1933. Type: United States: New Mexico: Sante Fe, *J. M. Holzinger s.n.,* 13 Aug 1911 (HOLOTYPE MO!).

Coreopsis tinctoria Nutt. var. *atropurpurea* Hook. forma *tinctoria* Sherff, Brittonia 6:341. 1948.

Coreopsis tinctoria Nutt. var. *tinctoria* forma *atropurpurea* (Hook.) Fern., Gray's Manual, 8th ed., p. 1947. 1950.

TYPE: United States: Arkansas: Red River, *Nuttall s.n.* (HOLOTYPE PH!; ISOTYPE BM!).

Blooming: May-Aug(Sep). Habitat: Roadside ditches, low wet sandy soil, railroad ballast. Chromosome number: $n = 12$ (+ 0-2 B).

This species (Fig. 48) is wide ranging (Fig. 49) through much of the central and eastern U.S. and was commonly cultivated a number of years ago under the name "Calliopsis." It was the subject of a biosystematic study by Smith & Parker (1971) and was included in a study by Parker (1973) in which most of the several segregates were shown to be merely phases. This variety apparently intergrades with var. *similis* in southern Texas (and with var. *atkinsoniana* of the Pacific Northwest—not treated in this paper—in western Idaho).

Attempted hybridizations (conducted by Parker (1973) and me) of *C. tinctoria* var. *tinctoria* with *C. grandiflora* var. *harveyana, C. grandiflora* var. *longipes, C. grandiflora* var. *saxicola, C. pubescens* var. *pubescens, C. pubescens* var. *debilis, C. intermedia, C. nuecensis, C. nuecensoides, C. basalis, C. wrightii, C. lanceolata, C. rosea, C. linifolia* ($n = 13$ and $n = 26$), *C. nudata,* and *C. falcata* all failed.

Successful hybridizations included:

C. tinctoria var. *tinctoria* × *C. leavenworthii.* This cross succeeded with var. *tinctoria* as the male parent; see *C. leavenworthii* for details.

C. *tinctoria* var. *tinctoria* × *C. gladiata.* Twelve F_1 hybrids of this combination were obtained. It represents the only successful intersectional hybridization of the study. The plants somewhat resembled *C. leavenworthii,*

Fig. 48. *Coreopsis tinctoria* var. *tinctoria;* achenes at upper left.

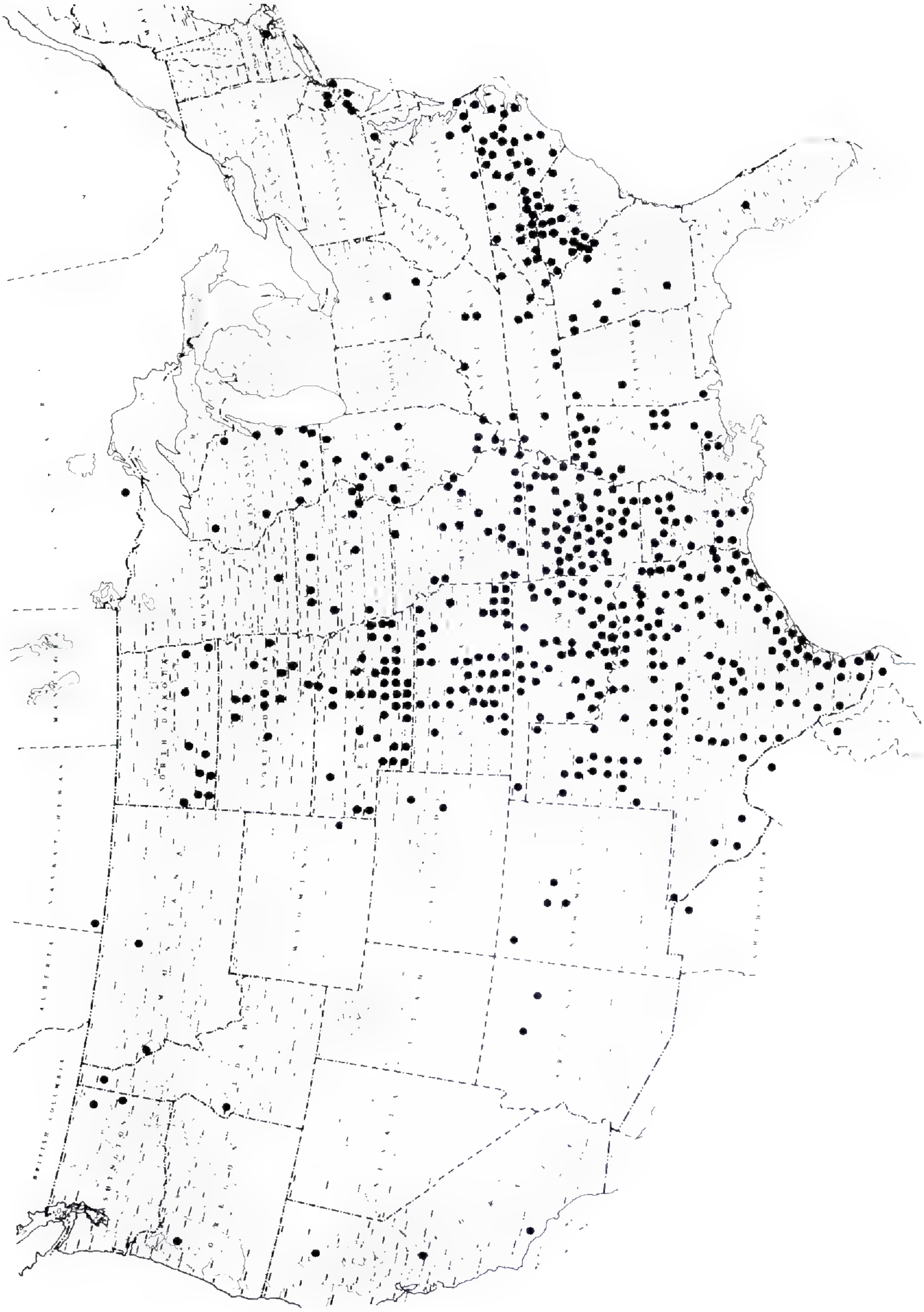

Fig. 49. Distribution of *C. tinctoria* var. *tinctoria*.

bearing weakly pinnate slightly leathery leaves. They averaged 4% pollen stainability. One plant at diakinesis of pollen meiosis exhibited variable and sometimes complex pairing, including $n = 1^{I}, 11^{II}, 1^{III}$; $n = 2^{I}, 12^{II}$; $n = 1^{I}, 10^{II}, 1^{V}$; $n = 1^{I}, 9^{II}, 1^{VII}$ etc.

After numerous attempts, no F_2 generation was obtained. A single BC_1 hybrid (*C. tinctoria* var. *tinctoria* the repeating parent) was obtained; it resembled *C. tinctoria* var. *tinctoria* and had 73% pollen stainability.

C. tinctoria var. *tinctoria* × *C. tinctoria* var. *similis*. Fifteen F_1 hybrids were obtained; they averaged 44% pollen stainability. Several analyzed at diakinesis of pollen meiosis exhibited $n = 1^{I}, 10^{II}, 1^{III}$. Varieties *tinctoria* and *similis* appear to differ chromosomally by a single reciprocal translocation.

25b. C. TINCTORIA Nutt. var. SIMILIS (F. Boynton) H. M. Parker *in* Smith, Bot. Gaz. 136:83. 1975.

Coreopsis similis F. Boynton *in* Small, Fl. SE U.S. 1278, 1340. 1903.

TYPE: United States: Texas: Brazos Co., *Nealley s.n.* 1899 (HOLOTYPE US!).

Blooming: Apr-May. Habitat: Low wet sandy areas. Chromosome number: $n = 12$.

This variety of southern Texas and northern Mexico (Fig. 50) apparently intergrades with var. *tinctoria* in southern Texas but can usually be distinguished on the basis of its bushy habit and relatively long achene awns. Parker (1973) has shown that it does not deserve species status.

In hybridization attempts by Parker (1973) and the author, *C. tinctoria* var. *similis* × *C. nuecensoides*, *C. basalis*, *C. wrightii*, and *C. rosea* all failed.

Successful hybridizations included:

C. tinctoria var. *similis* × *C. tinctoria* var. *tinctoria*—This cross was successful with var. *similis* as the pollen parent; see var. *tinctoria* for details.

C. tinctoria var. *similis* × *leavenworthii*—This cross was successful with var. *similis* as the pollen parent; see *C. leavenworthii* for details.

SUMMARY

Coreopsis of eastern United States and Canada was segregated by Sherff (1955) into 52 taxa including 30 species, 18 named varieties, and 4 named forms. He later (Sherff, 1962) added a 53rd taxon. A reexamination of the morphology of the group and studies of the chromosome numbers, breeding behavior in artificial hybridizations, and fertility of hybrids have convinced me that many of the taxa recognized by Sherff are mere populational segregates or phases of normal variation in a sexually reproducing species. My paper recognizes 34 taxa in eastern United States and Canadian *Coreopsis* (two are new species, added by me since Sherff's 1955 treatment), including 25 species, 6 named varieties, and 3 named forms.

The eastern United States and Canadian sections of *Coreopsis* are appar-

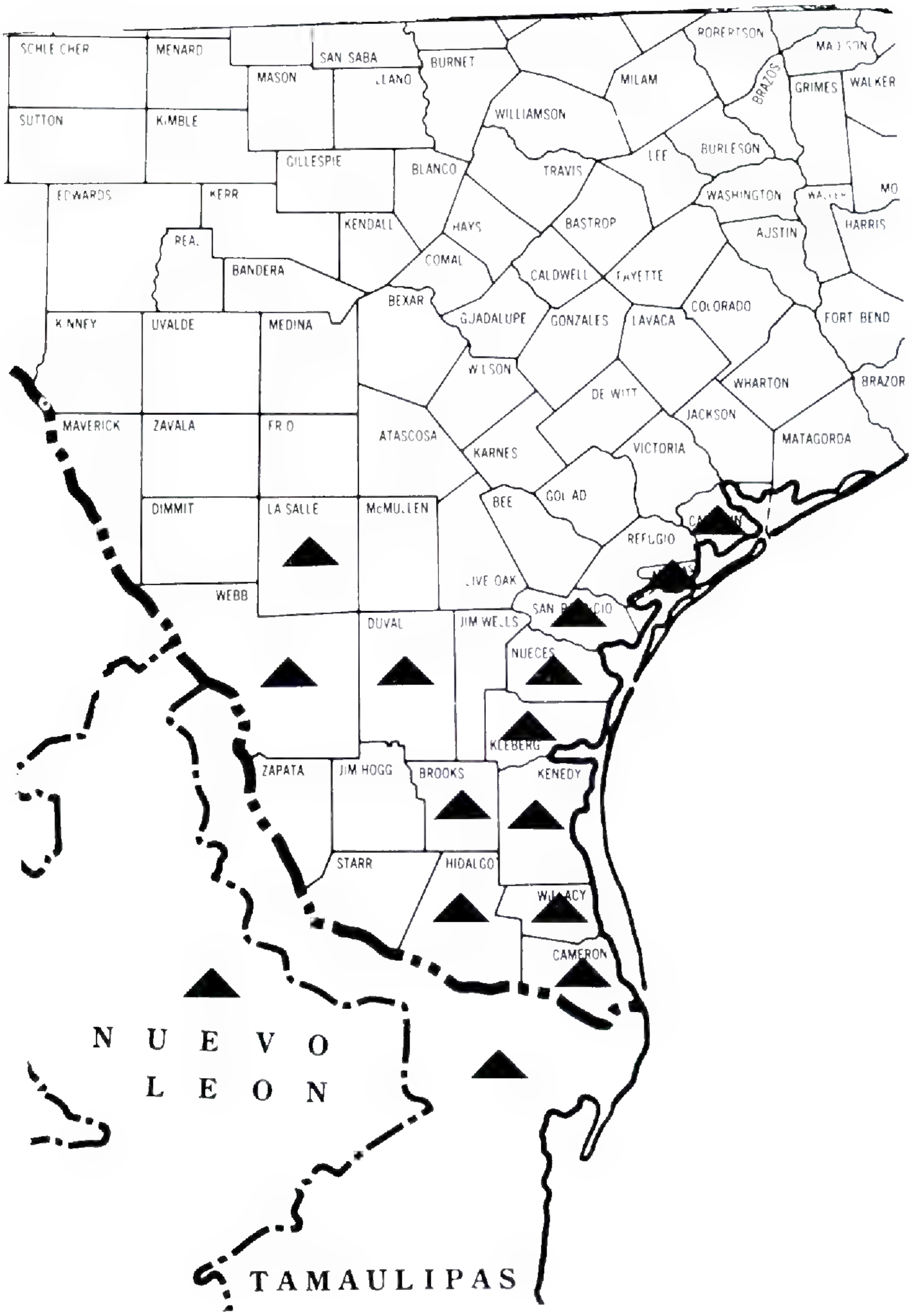

Fig. 50. Distribution of *C. tinctoria* var. *similis*.

ently completely isolated genetically from one another; intersectional hybridizations consistently fail. The lone exception to the rule is a low level of interfertility between sections *Calliopsis* and *Eublepharis*; these two sections are more closely related than any other two sections in eastern United States and Canada.

The species of *Coreopsis* are partly to completely isolated from one another by various pre- and post-fertilization barriers, including geographical, ecological, temporal, genic, and chromosomal barriers. Hybridization bar-

riers between different ploidy levels are apparently operative between (as well as within) some species. Evolutionary trends within the North American *Coreopsis* have been enumerated elsewhere (Smith, 1975); to these trends may be added: rhizomatous perennial to subcormose perennial or tap-rooted annual. Evolution within the sections may be the subject of a future paper on this group.

Eastern United States and Canadian *Coreopsis* is a complex and interesting group and many questions about it remain unanswered. Preliminary chromosome surveys indicate that B chromosomes are relatively common in sections *Coreopsis*, *Eublepharis*, and *Calliopsis* but uncommon in sections *Palmatae* and *Silphidium*. A study of their frequency, distribution, mode of transmission, homology, and effects on morphology and fertility might be illuminating. Expanded breeding experiments among the ploidy levels of the *C. major* complex would be useful. Artificial hybridizations of the various phases of *C. lanceolata*, as well as interspecific *C. lanceolata* × *C. grandiflora* hybridizations, should be pursued. Further study of the "heterolepis" phase of *C. grandiflora* var. *harveyana*, as well as a search for other such chromosomally different segregates within *C. grandiflora*, would prove interesting. Chromatography of the various ploidy levels in sections *Eublepharis* and *Palmatae*, and of the different taxa in all sections, would offer independent evidence of the relationships and origins of the taxa. Further studies in the group will attack one or more of the above problems.

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REFERENCES

AHLES, H. E., C. R. BELL, and A. E. RADFORD. 1958. Species new to the flora of North or South Carolina. Rhodora 60: 10-32.

AITON, W. 1789. Hortus Kewensis; or, a catalogue of the plants cultivated in the Royal Botanic Garden at Kew. Vol. 3.

ALEXANDER, E. J. 1932. A new *Coreop*sis from the southeastern United States. Torreya 32: 161.

BEADLE, C. D. 1898. Notes on the botany of the southeastern states. III. Bot. Gaz. 25: 446-450.
BERTOLONI, A. 1848. Miscellanea botanica septima. Novi Comment. Acad. Sci. Inst. Bononiensis 9: 185-228.
BLAKE, S. F. 1916. Compositae new and transferred, chiefly Mexican. Proc. Amer. Acad. Arts 51: 515-526.
BOYNTON, F. E. 1902. Two new southern species of *Coreopsis*. Biltmore Bot. Stud. 1: 141-142.
CANDOLLE, A. P. DE. 1836. Prodromus systematis naturalis. Vol. 5.
CASSINI, A. H. G. 1822. Leachie. Dict. Sci. Nat. 25: 388-393.
CRONQUIST, A. J. 1945. Notes on the Compositae of the northeastern United States. II. Heliantheae and Helenieae. Rhodora 47: 396-403.
CURTIS, W. 1791. *Coreopsis verticillata*. Whorled coreopsis. Bot. Mag. 5: pl. 156.
DEAM, C. C. 1940. Flora of Indiana. Indianapolis.
EAMES, E. H. 1916. Some varieties and forms of Connecticut plants. Rhodora 18: 239-240.
EHRET, G. D. 1749. Plantae et papilionex rariores depictae et incisae. London.
EHRHART, F. 1792. Beiträge zur Naturkunde, und den damit verwandten Wissenschaften. Vol. 7.
ELLIOT, S. 1823. A sketch of the botany of South Carolina and Georgia. Vol. 2.
FERNALD, M. L. 1919. *Coreopsis rosea* Nutt. forma *leucantha*, *n. f.* Rhodora 21: 171.
———. 1938. Noteworthy plants of southeastern Virginia. Rhodora 40: 364-424, 434-459, 467-485.
———. 1942. The seventh century of additions to the flora of Virginia. Rhodora 44: 457-479.
———. 1950. Gray's Manual of Botany, 8th ed. American Book Co., New York.
GRAY, A. 1852. Plantae Wrightianae Texano-Neomexicanae. Vol. 1.
———. 1884. Synoptical flora of North America. Vol. I^2.
GILBERT, F. A. 1940. The *Coreopsis major* complex in Cabell County. Proc. West Virginia Acad. Sci. 14: 54-55.
GREENE, E. L. 1901. New or noteworthy species. XXVIII. Pittonia 4: 233-241.
HELLER, A. A. 1895. Botanical explorations in southern Texas during the season of 1894. (Cont. Herb. of Franklin & Marshall College, No. 1).
HEYNHOLD, G. 1840. Nomenclator botanicus hortensis. Vol. 1.
HOOKER, J. D. 1879. *Coreopsis nudata*. Native of the southern United States. Bot. Mag. *pl.* 6419.
HOOKER, W. J. 1836. Bot. Mag. *pl.* 3460, 3474, 3484, 3511.
———. 1837. Bot. Mag. *pl.* 3586.
JACKSON, B. D. 1893. Index Kewensis plantarum phanerogamarum. Vol. 1.
JACQUIN, J. F. 1813? Eclogae plantarum rariorum. Vol. 1.
JONES, G. N. and G. D. FULLER. 1955. Vascular plants of Illinois. University of Illinois Press, Urbana.
LAMARCK, J. B. 1811. Encyclopedie methodique. Botanique. Supplement. Vol. 2.
LESSING, C. F. 1832. Synopsis generum compositarum. I-XI.
LINK, J. H. F. 1822. Enumeratio plantarum Horti Regii Botanici Berolinensis altera. Vol. 2.
LINNAEUS, C. 1753. Species Plantarum.
MELCHERT, T. E. 1961. Heliantheae of Wisconsin. Unpub. M.S. Thesis, Dept. Botany, University of Wisconsin, Madison.
MICHAUX, A. 1803. Flora boreali-americana. Vol. 2.
MOENCH, C. 1794. Methodus plantas Horti Botanici et Agri Marburgensis. pp. 594-595.
NUTTALL, T. 1818. The genera of North American plants. Vol. 2.
———. 1821. A description of some new species of plants, recently introduced into the gardens of Philadelphia, from the Arkansas territory. J. Acad. Nat. Sci. Philadelphia 2: 114-123.
———. 1834. A description of some of the rare or little known plants. J. Acad. Nat. Sci. Philadelphia 7: 61-115.
———. 1841. Descriptions of new species and genera of plants. Trans. Amer. Philos. Soc., II. 7: 283-453.
OTTO, C. F., and A. DIETRICH. 1835. *Calliopsis basalis* Nob. eine neue schönblühende Pflanze. Allg. Gartenzeitung 3: 329-331.
PARKER, H. M. 1973. A biosystematic study of section *Calliopsis* of *Coreopsis* (Com-

positae). Unpub. Ph.D. dissertation, Dept. Botany & Bact., University of Arkansas, Fayetteville.
PLUKENET, L. 1769. Leonardi Plukenetti phytographia. F. 4, pl. 242.
RADFORD, A. E., H. E. AHLES, and C. R. BELL. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill, N.C.
RADFORD, A. E., W. C. DICKISON, J. R. MASSEY, and C. R. BELL. 1974. Vascular plant systematics. Harper & Row, New York.
REICHENBACH, H. G. L. 1823. Icones et descriptiones plantarum cultarum et colendarum addita colendi ratione. Vol. 2.
ROBINSON, B. L. 1908. Further notes on the vascular plants of the northeastern United States. Rhodora 10: 64-68.
SCHKUHR, C. 1803. Botanisches Handbuch der mehresten Theils. Vol. 3.
SCHRANK, F. 1817. *Anacis*, eine neue Pflanzengattung. Denkschr. Königl. Akad. Wiss. München 5 (Math. Naturw.): 5.
SHELTON, L. S. 1968. An isolated species of *Coreopsis* on a granite monadnock. Bull. Torrey Bot. Club 95: 166-171.
SHERFF, E. E. 1929. New or otherwise noteworthy Compositae. III. Bot. Gaz. 88: 285-309.
. 1930. New or otherwise noteworthy Compositae. IV. Bot. Gaz. 89: 362-373.
. 1933. New or otherwise noteworthy Compositae. VIII. Bot. Gaz. 94: 589-597.
. 1936. Revision of the genus *Coreopsis*. Field Mus. Nat. Hist., Bot. Ser. 11: 277-475.
. 1944. New or otherwise noteworthy American and Hawaiian Coreopsideae. Amer. J. Bot. 31: 277-281.
. 1948. A name for the "alpha" variety or forma of miscellaneous dicotyledonous plants. Brittonia 6: 332-342.
. 1952. Notes on *Bidens* L. and *Coreopsis* L. (fam. Compositae) in the United States. Bot. Leafl. 6: 2-6.
. 1955. *Coreopsis*, pp. 4-40 *in* E. E. Sherff & E. J. Alexander, Compositae-Heliantheae-Coreopsidinae. North Amer. Flora II. Pt. 2.
. 1962. New Coreopsidinae from Mexico and the United States. Brittonia 14: 172-173.
SMALL, J. K. 1895. Studies in the botany of the southeastern United States. Bull. Torrey Bot. Club 22: 43-48.
. 1898. Studies in the botany of the southeastern United States. XIII. Bull. Torrey Bot. Club 25: 134-151.
. 1903. Flora of the southeastern United States. Pub. privately.
. 1933. Manual of the southeastern flora. New York.
SMALL, J. K., and A. M. VAIL. 1894. Report of the botanical exploration of southwestern Virginia during the season of 1892. Mem. Torrey Bot. Club 4: 93-201.
SMITH, E. B. 1968a. *In* IOPB chromosome number reports. XIX. Taxon 17: 573-577.
. 1968b. *Coreopsis saxicola* Alex var. *duncanii* Sherff (Compositae) in Arkansas. Proc. Arkansas Acad. Sci. 22: 62-63.
. 1968c. Supernumerary chromosomes in *Haplopappus validus* (Rydb.) Cory. Evolution 22: 748-750.
. 1969a. *In* IOPB chromosome number reports. XXII. Taxon 18: 433-442.
. 1969b. *In* IOPB chromosome number reports. XXIV. Taxon 18: 683-684.
. 1971. *In* IOPB chromosome number reports. XXXIV. Taxon 20: 785-797.
. 1972. Lobing of the disk flower corollas in North American *Coreopsis* (Compositae). Brittonia 24: 87-89.
. 1973a. *In* IOPB chromosome number reports. XXXIX. Taxon 22: 115-118.
. 1973b. A biosystematic study of *Coreopsis saxicola* (Compositae). Brittonia 25: 200-208.
. 1973c. *In* IOPB chromosome number reports. XLI. Taxon 22: 459-464.
. 1974a. *Coreopsis nuecensis* (Compositae) and a related new species from southern Texas. Brittonia 26: 161-171.
. 1974b. Variation in ligule spotting in *Coreopsis basalis*. Proc. Arkansas Acad. Sci. 28: 72-73.
. 1975. The chromosome numbers of North American *Coreopsis*, with phyletic interpretations. Bot. Gaz. 136: 78-86.
SMITH, E. B., and H. M. PARKER. 1971. A biosystematic study of *Coreopsis tinctoria* and *C. cardaminefolia* (Compositae). Brittonia 23: 161-170.

SPRENGEL, K. P. J. 1826. Caroli Linnaei systema vegetabilium. Vol. 3.
STANDLEY, P. C. 1930. New forms and varieties of Indiana plants. Rhodora 32: 32-34.
STEYERMARK, J. A. 1963. Flora of Missouri. Iowa State University Press, Ames.
TAUSCH, I. F. 1823. Hortus canalius seu plantarum rariorum, *pl.* 15.
THOMAS, J., and T. BALDWIN. 1859. Lippincott's pronouncing gazetteer of the world. J. B. Lippincott & Co., Philadelphia.
TORREY, J., and A. GRAY. 1842. Flora of North America. Vol. 2.
WALTER, T. 1788. Flora caroliniana, secundum systema vegetabilium.

VARIETIES OF IPOMOEA TRICHOCARPA (CONVOLVULACEAE)

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In the past ninety-five years several varieties in the *Ipomoea trichocarpa* alliance have been named. The first of these was proposed by Gray (1878) under the species *I. trifida.* Both Shinners (1953) and O'Donell (1960) have indicated the distinctness of *I. trichocarpa* and *I. trifida;* I will discuss their distinctness further in another paper (Austin, in preparation). During the same year that Shinners transferred Gray's variety to *I. trichocarpa,* O'Donell (1953) described a new variety of this species from South America. Little has been written about the South American taxon since (O'Donell, 1959). During my studies of the genus *Ipomoea* (Abel & Austin, 1973; Austin, 1973, 1974, in preparation) I have examined specimens of all these named varieties; a resumé now seems in order.

The type of *I. trichocarpa* originated in the Carolinas of the eastern United States (Dillenius, 1732). Linnaeus used the Dillenius specimen as the basis for his *Convolvulus carolinus* (Linnaeus, 1753: 154; see also Schmidt, 1965), the senior synonym for *Ipomoea trichocarpa.* As Gray (1878) and Shinners (1953; Correll & Johnston, 1970) have pointed out, there are two distinctive morphological variations of *I. trichocarpa* in Texas. The eastern morph is the tautonymic variety, while the western morph is var. *torreyana.* Shinners (1953) proposed that, while these two intergrade at their point of contact, they ought to be recognized as distinct taxonomic units.

O'Donell (1953) questioned the distinctness of var. *torreyana* from var. *trichocarpa.* His major basis for this was the occurrence of glabrous forms known to him from Florida (Shinners, 1953). I have seen and collected glabrous forms in Florida; my student W. E. Abel has studied glabrous forms in South Carolina; and I have examined herbarium material of the glabrous forms from Louisiana. Thus far every glabrous "*I. trichocarpa*" we have seen from Florida and South Carolina has been a hybrid between *I. trichocarpa* and *I. lacunosa* (Abel & Austin, 1973). Glabrous forms are rare in Louisiana, but those seen usually occur with integrades of var. *torreyana* and var. *trichocarpa.* Hybrids have also been found between *I. lacunosa* and both *I. trichocarpa* varieties (Abel, in preparation).

Shinners neglected to point out as supporting evidence that the two U.S. varieties occupy different ecological habitats in Texas. It is only where the Plains and Prairies meet the Deciduous Forest that the morphs intergrade.

SIDA 6(3): 216—220. 1976.

In fact, var. *torreyana* is a population almost exclusively contained in the Plains and Prairies provinces of Texas (Fig. 1). Some Texas plants of this variety are known from east of the major line of integrades, but Shinners (Correll & Johnston, 1970) suggested that they were introduced. The var. *trichocarpa* is mostly contained within the boundaries of the Deciduous Forest vegetation. Again, those few collections of var. *trichocarpa* from west of this floristic province are most likely introductions by man (Fig. 1). *Ipomoea trichocarpa* is easily dispersed outside its home range in the United States as witnessed by casual plants from northwestern Mexico (Matuda, 1963), Cuba (Leon & Alain, 1957), Jamaica (Adams, 1970), and Guatemala, Honduras, and Colombia (Austin, in preparation).

Shinners (1953) was of the opinion that the presence of glabrous forms in Florida represented a natural bicentric distribution of var. *torreyana* as is known in some other families. This hypothesis cannot be substantiated with the present data, nor can it be completely negated. It has been our observation that the glabrous forms outside central Texas occur in some association with a man-made disturbance, e.g. motel trash dumps, filling stations, roadside ditches. Our data suggest that var. *torreyana* did not exist east of Texas until man became the major dispersal agent for the species.

The South American var. *australis* is known only from a phytogeographic association called the "Chaco." The earliest collections were apparently made in the 1880's; the "Chaco" has been an area of difficult access, and few botanists visited it until fairly recently. Morphologically this population is similar to var. *trichocarpa*, and its origin appears to have been an introduction and naturalization of that population.

TAXONOMY

IPOMOEA TRICHOCARPA Ell., Bot. S.C. & Ga. 1: 258. 1817.
Type: based on Convolvulus folio hederaceo, etc. *Dillenius* collection (lectotype OXF).

Convolvulus carolinus L., Sp. Pl. 154. 1753. Based on the *Dillenius* specimen at Oxford (Schmidt, 1965).

Ipomoea carolina (L.) Pursh, Fl. Amer. Sept. 1: 145. 1814, not L. (1753) nom. illegit.

I. commutata Roem. & Schult., Syst. Veg. 4: 228. 1819. New name for *C. carolinus* L.

I. caroliniana Pursh in Small, Fl. Southeast. U.S. 963. 1903. New name for *I. carolina* (L.) Pursh.

According to O'Donell (1953) the Dillenius specimen was at Oxford in the 1950's. In 1974 the Curator of the Herbaria, Dr. F. White, was unable to locate the type specimen. The format of Linnaeus' discussion of *Convolvulus carolinus* (1753: 154) indicates that he had the Dillenius specimen when the description was prepared, thus the plate should not be chosen as the lecto-

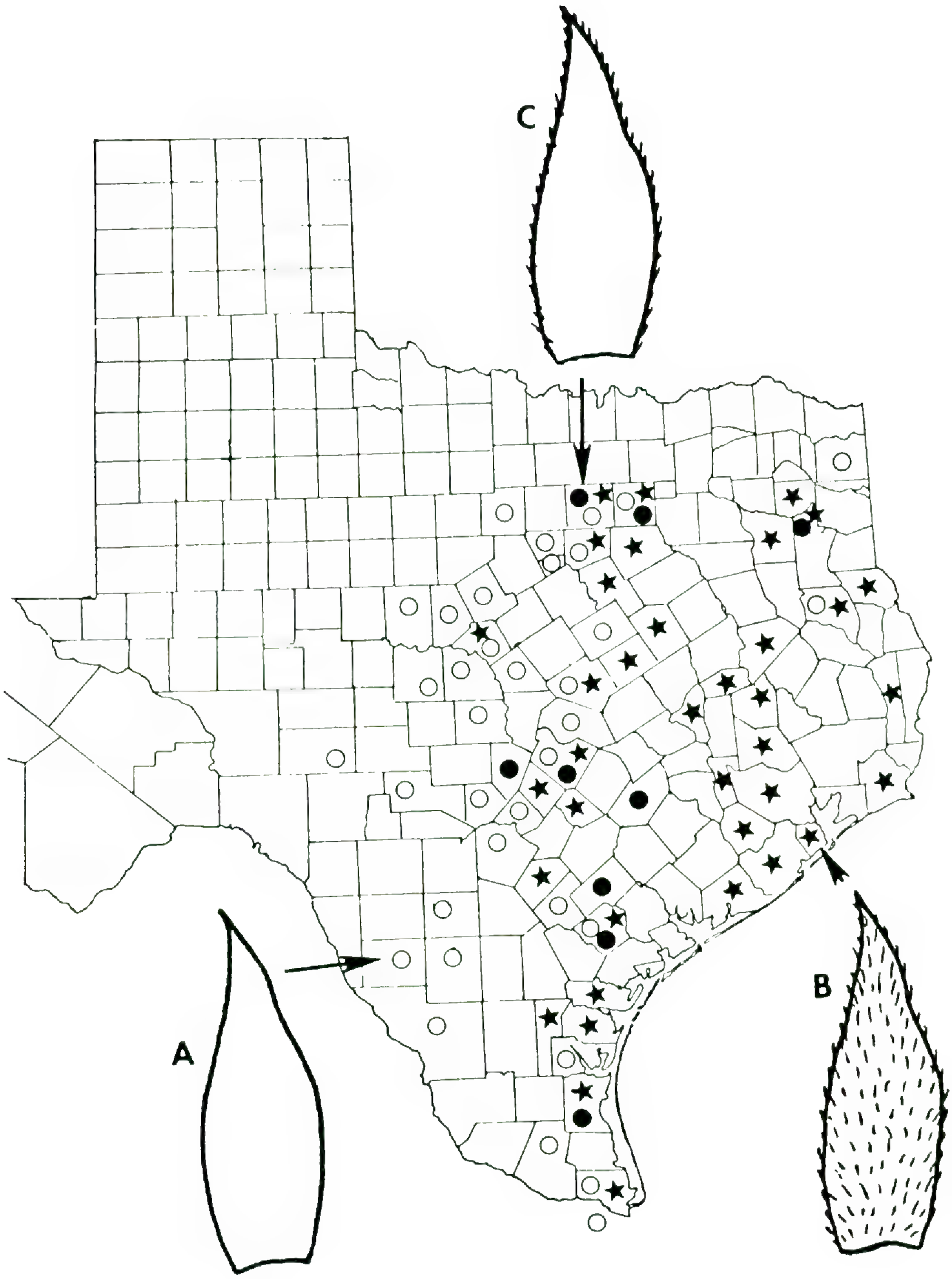

Fig. 1. Distribution of varieties of *Ipomoea trichocarpa* in Texas. A. variety *torreyana* (Gray) Shinners; B. variety *trichocarpa;* C. intergrades. Symbols: open circle = var. *torreyana;* closed circle = intergrades; star = var. *trichocarpa.* Note that the major focus of intergrades follows a line about parallel with the border of the Deciduous Forest and the Plains and Prairie provinces.

type. The Dillenius collection was effectively chosen as lectotype by Schmidt (1965: 82).

The type specimen and plate are not typical of var. *trichocarpa* and O'Donell (1953) suggested that the type could represent the same population as *I. lacunosa* f. *purpurata* Fernald. The type specimen of this form (*Fernald & Long 7580* GH) I believe to be a backcross hybrid segregate of *I. lacunosa* and *I. trichocarpa*. The type of *I. trichocarpa* is also probably of hybrid origin. Due to introgressive hybridization between *I. lacunosa* and *I. trichocarpa* (Abel & Austin, 1973; Abel, in preparation), pure populations of *I. trichocarpa* appear to be rare if not non-existant.

KEY TO VARIETIES

a. Sepals glabrous . . . . . 2. var. *torreyana*
aa. Sepals pubescent or at least ciliate.
  b. Pedicels muricate; leaves 3-5-lobed, mostly 3-lobed with the base of the median lobe contracted . . . . . 1. var. *trichocarpa*
  bb. Pedicels smooth, rarely somewhat muricate; leaves entire to 3-lobed, rarely 5-lobed, the middle lobe not contracted at the base. . . . . 3. var. *australis*

1. *I. trichocarpa* var. *trichocarpa*

A native of the southeastern United States, this variety is found in the Coastal Plain Province of the Eastern Deciduous Forest. Sepals are pubescent on the backs or at least ciliate. Those with only ciliate margins are mostly intergrades with var. *torreyana*. This variety ranges from eastern Texas to southern North Carolina, south into southern Florida.

2. *I. trichocarpa* var. *torreyana* (Gray) Shinners, Field & Lab. 21: 164. 1953.
Basionym: *I. trifida* var. *torreyana* Gray, Syn. Fl. N. Amer. 2(1): 212. 1878.

Lectotype: Rio Grande, western Texas, anno 1848, *Wright s.n.* (GH).

Syntypes: Sept. 1849, *Lindheimer s.n.* (GH, MO, NY); *Bigelow,* (presumably GH, not found); *Schott s.n.* (NY).

Synonym: *I. trifida* var. *berlandieri* Gray, Syn. Fl. N. Amer. 2(1): 212. 1878.
Type: Bexar, Texas, *Berlandier 546 (1931)* (holotype GH; isotypes MO, NY).

When he published var. *berlandieri* Gray suggested that it might be only a depauperate form. The type is but one of the apparently ecophenotypic variations of the species.

The glabrous var. *torreyana* is normally found within the Plains and Prairies Provinces of Texas and adjacent Mexico (Tamulipas). Some of the locations in Mexico (Chihuahua, Mazatlan, Guaymas) are introductions. There are a few plants known from east of Texas in the United States.

3. *I. trichocarpa* var. *australis* O'Donell, Bol. Soc. Argentina Bot. 4: 260. 1953.

Type: *Lillo 12909* (holotype LIL, not seen; isotype NY).

Additional specimens seen: Argentina: *Peirano 9497* (NY); *Schreiter 946* (NY). Paraguay: *Morong 253* (NY).

O'Donell's variety is known only from the Gran Chaco region of Bolivia, Paraguay, and Argentina. From the specimens that I have seen, this variety also has larger trichomes on the calyx, and sepals which are more herbaceous than var. *trichocarpa*.

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REFERENCES

ABEL, W. E. in preparation. Introgressive hybridization between *Ipomoea lacunosa* and *Ipomoea trichocarpa*. M.S. thesis: Florida Atlantic University.

and D. F. AUSTIN. 1973. Natural hybridization in *Ipomoea* (Convolvulaceae). Amer. J. Bot. 60: 33-34. (abstract).

ADAMS, C. D. 1970. Convolvulaceae *In* Flowering plants of Jamaica. pp. 601-614. Univ. W. Indies Press, Mona.

AUSTIN, D. F. 1973. The sweet potato allies: a taxonomic review. Quart. J. Fla. Acad. Sci. 36 (Suppl. 1): 7. (abstract).

_. 1974. Convolvulaceae *In* Flora of Panama, Ann. Missouri Bot. Gard. (in press).

___. in preparation. The *Ipomoea batatas* complex.

CORRELL, D. S. and M. C. JOHNSTON. 1970. Convolvulaceae *In* Manual of the vascular plants of Texas. pp. 1241-1261. Texas Research Foundation, Renner.

DILLENIUS, J. J. 1732. Hortus Elthamensis seu plantarum rariorum quas in horto suo Elthami in Cantio coluit, etc. p. 100, *t. 84, f. 98*. London.

GRAY, A. 1878. Convolvulaceae *In* Synoptic flora of North America 2(1): 207-224.

LEON, BRO. and BRO. ALAIN. 1957. Convolvulaceae *In* Flora of Cuba 4: 218-248. Habana.

LINNAEUS, C. 1753. Species Plantarum. p. 154. Vindobonae.

MATUDA, E. 1963. El genero Ipomoea en Mexico (I). An. Inst. Biol. Mex. 34: 85-145.

O'DONELL, C. A. 1953. Una nueva Convolvulacea Sudamericana. Bol. Soc. Argentina Bot. 4: 260-263.

. 1959. Convolvulaceas Argentinas. Lilloa 29: 88-348. pl. I-V.

. 1960. Notas sobre Convolvulaceas Americanas. Lillea 30: 39-69.

SCHMIDT, H. 1965. Der "Hortus Elthamensis" aus der Bibliothek Carl von Linnes. Fedde Rep. 70: 69-108.

SHINNERS, L. H. 1953. Botanical notes. Field & Lab. 21: 164-165.

TWO SPECIES OF THE "FILAGO GERMANICA" GROUP (COMPOSITAE-INULEAE) IN THE UNITED STATES

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In the past there has been considerable discrepancy regarding species-delimitation in the genus *Filago* especially as concerns the group centering around "Filago germanica" (a name which for nomenclatural reasons cannot be maintained and has to be replaced by *Filago vulgaris* Lam.—Wagenitz, 1965). Some authors have used the name "Filago germanica" in a collective sense, but our monographic studies have confirmed the view of those authors, who have distinguished several species in this complex (Wagenitz, 1965, 1969). These species differ by inconspicuous but very constant characters.

In North America "Filago germanica" has been known for a long time from the eastern part of the United States and has recently been reported also from Oregon and California. A closer inspection of these plants is necessary.

1. Eastern North America

Clayton seems to have been the first American botanist who collected a *Filago* of this group in eastern North America, in Virginia. This find was published by Gronovius (1739). Although the name used ("Gnaphalium minimum humile, Herba Impia dictum") may not be unequivocal, the fact is confirmed by a specimen from Virginia from the herbarium of Gronovius (in herb. Jacquin, Vienna). Later on the species is mentioned under the name of "Gnaphalium germanicum" or "Filago germanica" in most of the classical floras of this area (e.g. Pursh 1814, Barton 1818, Darlington 1837, Torrey 1843, Torrey & Gray 1843). Barton considered it to be a native species, but the opinion prevailed that it was introduced from Europe. This appears to be very probable, but as the spread of the plant apparently took place before the beginning of a floristic study of the continent no direct evidence is available. Uechtritz (1871: 190) seems to have been the first author who critically examined the material of "Filago germanica" from North America after it had been established that there is more than one species of this group in Central Europe. He concluded that the American plants belong to "Filago canescens Jord." (*F. germanica* s.str. of most later authors), now correctly called *F. vulgaris* Lam. This conclusion has

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been fully confirmed by our studies. During the revision of material from numerous herbaria of Europe and several from the United States (GH, NY, POM, UC), 43 collections all belonging to *Filago vulgaris* Lam. have been seen from the following states: New York, New Jersey, Pennsylvania, Delaware, District of Columbia, Maryland, Virginia, West Virginia, North Carolina, South Carolina. According to Fernald (1950), the species is also known from Ohio and Georgia. It is remarkable that only 11 of these collections are dated in this century, the latest from 1947. This may be due either to a diminishing activity of floristic botany in the last decades or to a decrease of the species on account of more intensive cultivation as noted in Europe.

2. Western North America

The first record from this area was published by J.Th. Howell (1939) and referred to a plant collected by Mr. Lewis S. Rose in Roseburg, Douglas Co., Oregon. I have examined a fragment of this plant sent to me by the courtesy of Mr. Howell and can confirm that it is *F. vulgaris* Lam. This may have been a casual introduction from the Eastern states.

Of more interest is the material collected in California since 1935 by Tracy and Lennon (see the short notes of Howell, 1942 and 1973 and Munz, 1968). All three collections so far known have been studied by me and they belong to *Filago pyramidata* L. (syn.: *F. spathulata* C. Presl), a mainly Mediterranean plant extending into the southern parts of Central Europe and the Near East (Wagenitz, 1970). It is not surprising that the Mediterranean representative of this group is introduced (and perhaps locally naturalized) in California as the high percentage of species with this type of distribution in the California weed-flora is very well known. In fact another Mediterranean *Filago*-species (belonging to another section) has been naturalized for a long time: *F. gallica* L. The distinction of the two species of the "Filago germanica" group is not difficult especially if the capitula are studied under the binocular.

The main differences are:

	Filago pyramidata	*F. vulgaris*
Leaves	oblong-spathulate (broadest near apex)	lanceolate (broadest near middle)
Phyllaries of involucre	in 5 distinct rows, keeled on back	not in 5 distinct rows, rounded on back
Median phyllaries	with short straight point	with spreading mucro
Flowers in central part of involucre	5-6 hermaphrodite, few female flowers	2-3 hermaphrodite, numerous filiform female flowers
Number of capitula in cluster	20-30 (40)	8-16

It seems appropriate to cite in full the three collections of *Filago pyramidata* L. known from California:

Mendocino County: near Hopland (along highway ten miles south), dry hillside, 600 feet, 18.VIII.1935, *J. P. Tracy 14741* (JEPS)

Mendocino County: between Hopland and Cloverdale, locally naturalized along highway on dry hillsides, 600 feet, 6.VI.1938, *J. P. Tracy 15848* (DS, GH, JEPS, NY, UC)

Marin County: dry open hills above Kirby Cove, Marin Headlands State Park, just west of Golden Gate Bridge, 28.V. & 3.VII. 1971, *Elizabeth S. Lennon* s.n. (CAS)

Californian field-botanists should keep a close eye on this species, which may be expected to spread farther in the state. It is not a serious weed, but an interesting addition to the flora of California.

REFERENCES

BARTON, W.P.C. 1818. Compendium Florae Philadelphicae. Philadelphia.

DARLINGTON, W. 1837. Flora cestrica. Ed.2. West-Chester.

FERNALD, M. L. 1950. Gray's manual of botany. Ed.8. New York.

GRONOVIUS, J. F. 1739. Flora Virginica. Pars 1. Lugduni Batavorum.

HOWELL, J.Th. 1939. *Gifola germanica* (L.) Dumort. Leafl. Western Bot. 2: 192.

_____. 1942. Now in California. Leafl. Western Bot. 3: 168.

_____. 1973. A new California record for *Filago vulgaris*. Madroño 22: 151.

MUNZ, P. A. 1968. Supplement to a California flora. Berkeley and Los Angeles.

PURSH, F. 1814. Flora Americae Septentrionalis. London.

TORREY, J. 1843. A flora of the state of New York. Vol. 1. Albany. (= Natural History of New York. Part 2. Botany.)

_____ and A. GRAY. 1843. A flora of North America. Vol. 2 Part 3. New York and London.

UECHTRITZ, R.v. 1871. Zur Flora Ungarns. Oesterr. Bot. Ztschr. 21: 185-191, 233-237, 262-265, 306-310, 340-343.

WAGENITZ, G. 1965. Zur Systematik und Nomenklatur einiger Arten von *Filago* L. emend. Gaertn. subgen. *Filago* ("Filago germanica"—Gruppe). Willdenowia 4: 37-59.

_____. 1969. Abgrenzung und Gliederung der Gattung *Filago* L. s.l. (Compositae-Inuleae). Willdenowia 5: 395-444.

_____. 1970. Uber die Verbreitung einiger *Filago*-Arten. Feddes Repert. 81: 107-117.

DRYOPTERIS XLEEDSII AND ITS WESTERNMOST STATION[1]

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Dryopteris ×*leedsii* Wherry, Leeds' hybrid, is perhaps the most taxonomically confused of all eastern American woodferns. No other North American fern genus has received so much attention in recent years as *Dryopteris*, and the study of these plants reveals approximately three dozen taxa, of which two-thirds are sterile hybrids (Wagner, 1970). To the south and west the numbers of individuals and taxa become greatly diminished, as in the Gulf States and west of the Mississippi River. Thus, in Arkansas, woodferns are relatively rare. The occasion for this paper is the rediscovery of a long-problematic plant referred to as the "Palmer Dryopteris," found nearly fifty years ago and collected several times after that in a single locality in Arkansas. The study of this fern has forced us to review our knowledge of D. ×*leedsii* and related taxa, and we present the results of this review here.

As early as 1819, Thomas Nuttall (McKelvey, 1955) gave attention to the pteridophytes of Arkansas, which are currently being studied by one of us (Taylor). Of those who have made significant contributions to Arkansas pteridology in the past (Lesquereux, 1860; Harvey, 1881; Branner and Coville, 1891; Buchholz, 1924; Buchholz and Palmer, 1926; Scully, 1937, 1939; Moore, 1940a, b, 1941; and Demaree, 1943), no less than three, Palmer, Moore, and Demaree, have been concerned with the nature of the problematic *Dryopteris*. In spite of numerous field collections in Arkansas, especially since 1940, no new localities for the fern in question have been discovered, and the fern itself was not rediscovered at its original locality for almost 40 years.

A brief, published mention of the Palmer *Dryopteris* was given by Small (1938, p. 286). Because of its rather unusual nature, we expand its history here, based upon data from herbarium collections, and unpublished letters belonging to Delzie Demaree. Suffice it to say, not long after its original discovery, the fern attracted considerable attention from a number of individuals on the East Coast, including Small himself, W. R. Maxon, and E. T. Wherry. The main source of interest lay in the possibility that the plant might in fact represent a new and undescribed taxon. As will be shown, it really was a new taxon.

The plant was originally found by E. J. Palmer near Shirley, Arkansas, Van Buren County, on 30 March 1928 (*Palmer 33216*, NY, US) and identified as "*Dryopteris cristata* (L.) Gray." The specimens cited bear other identi-

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fications as "*D. celsa* E. T. W[herry]" and "*D. celsa* × *spinulosa* F. W. Crane." Both specimens have a ragged, coarsely lobed appearance, as if they had perhaps been grazed during growth or the plants had been damaged. Most of the later collections are more regular and more finely lobed. In 1932 there were collections by Delzie Demaree on 4 November (*Demaree 10039*, US—3 sheets). These were annotated by F. W. Crane (investigator on *Dryopteris*, especially comparative spore structure, during the 1950's) as "*D. celsa* × ?". On 3 November 1935, new collections were made at the same locality by Dwight M. Moore (*Moore 350441*, NY, US—2 sheets) and were annotated by Crane as "*D. celsa* × *marginalis*." A specimen of this collection in the Philadelphia Academy was annotated by Small as "*D. separabilis*."

William R. Maxon grew a living specimen of the Palmer *Dryopteris* at his home in Washington, D. C. from a rhizome sent to him by Demaree in 1932. We know (Maxon, *in litt.* 20 September 1933) that the fern survived at least through one summer, because he wrote to Demaree, "Your Arkansas *Dryopteris* has done remarkably well . . . ," and "it is an exceptionally attractive fern in cultivation." Evidently it did die, however, as there is no further mention of it, nor are there specimens from the cultivated plant in the National Herbarium. Maxon recognized that it was probably a new taxon. In a letter to Demaree (10 November 1932), Palmer wrote, "I have just had a letter from Dr. Maxon asking about a *Dryopteris* collected [at Shirley]. . . . He seems interested in it and thinks it is an undescribed species." Thus we have all the following interpretations that have been suggested for the Palmer *Dryopteris* through the years: *D. cristata*, *D. celsa*, *D. celsa* × *spinulosa*, *D. celsa* × ?, *D. celsa* × *marginalis*, *D. separabilis*, and an undescribed species.

In 1964, Wagner, in company with Delzie Demaree and Paul Redfearn, attempted to rediscover the Palmer *Dryopteris* but without success. It was not until August, 1974, that the plant was rediscovered. Taylor, in company with Demaree, found what may be at least a remnant of the original colony (or clone) from which the first specimens were taken.

The locality and habitat of the Palmer *Dryopteris* may be described as follows: Van Buren Co., ½ mi. SW of Shirley, NW ¼ of sect. 25, R13W, T12N, in moist, rocky woods below northeast-facing bluffs along the west bank of the Middle Fork of the Little Red River, on the Atoka Formation (shale and sandstone) of the Pennsylvanian Period, alt. 800-1000 ft. Conspicuous trees on the slope are *Acer saccharum*, *Carya* sp., *Carpinus caroliniana*, *Celtis occidentalis*, *Cornus florida*, *Fraxinus americana*, *Lindera benzoin*, *Quercus muehlenbergii*, and *Q. rubra*. Among the smaller woody plants are *Asimina triloba*, *Cercis canadensis*, *Corylus americana*, *Euonymus americana*, *Hydrangea arborescens*, *Smilax* sp., and *Toxicodendron radicans*. Students of the Ozarkian flora will recognize from these indicators the rich nature of the habitat. The soil here is very fertile, dark, sandy

loam. Among the herbs are *Asarum canadense* and *Polymnia canadensis*. The associated ferns on the slope are *Adiantum pedatum, Polystichum acrostichoides,* and especially *Dryopteris marginalis*. The plants of the Palmer *Dryopteris* grow on the loose talus below the shale-sandstone cliffs. On the rocks directly associated with the colony are the mosses, *Anomodon attenuatus, A. rostratus,* and *Hedwigia ciliata*. The colony consists of 8-10 plants in an opening in the understory. The plants are concentrated in an area only about 4 feet in diameter in among the Atoka sandstone rubble. By October, all of the once stately fronds are lying down, criss-crossing each other.

VARIATION AND IDENTIFICATION OF THE PALMER DRYOPTERIS

The Palmer *Dryopteris* may be distinguished from the associated *D. marginalis* by its much larger fronds which taper basally, by the darker green color, thinner texture, and different position of the sori. Fertile fronds as tall as 45 inches, and sterile fronds as tall as 35 inches are represented in collections of *Wagner and Wagner 74164* (MICH). There is some evidence that it may reach even larger size, judging from a fragment of a frond from a Moore collection in 1935, deposited at the Philadelphia Academy. The distinctive color and texture of the fronds is due, apparently, to differences in the structure of the mesophyll. In *D. marginalis,* the color and rubbery texture appear to be due to the extremely large, stellate parenchyma cells of the mesophyll, whose almost worm-like arms result in extensive intercellular air-spaces. The Palmer *Dryopteris* is more like the usual condition in eastern American species, with smaller, more compact cells in the mesophyll. The position of the sori on the questionable plant is decidedly not marginal. Instead, the sori are located approximately one-third to one-half of the way to the costa.

The pinnules of different collections of the Palmer *Dryopteris* vary considerably in size and shape. Normally they are broadly adnate at their bases, but some are contracted, especially on very large fronds. The pinnules of the largest pinnae range from 0.4-0.9 cm. in maximum width and ca. 2-4 cm. in length. The most distinctive collections differ from the rest mainly in the structure of their pinnules. In the Philadelphia Academy, one of Moore's specimens taken in 1935 is represented only by a section of the blade which practically fills the herbarium sheet. The pinnules are

Figure 1. Comparison of two woodfern hybrids. Note relative petiole lengths, blade outlines, pinna numbers and shapes, and sizes of basal pinnae. LEFT: *Dryopteris* ×*neo-wherryi* (*D. goldiana* × *marginalis*), "Goldiana Valley," near Mountain Lake, Giles Co., Va., *Wagner and Wagner 70386* (MICH). CENTER: *D.* ×*leedsii* (*D. celsa* × *marginalis*), Shirley, Van Buren Co., Arkansas, *Wagner and Wagner 74164* (MICH). RIGHT: The same, *Redfearn 29403* (MICH).

25cm

strongly separated and are pinnatifid up to one-fourth of the distance to the costa. Also they are conspicuously contracted at their bases in the lower half of the pinnae, thus making the frond bipinnate-pinnatifid. The peculiar characteristics of this fragment are undoubtedly attributable to the very large size of the frond from which it came.

The 1928 Palmer specimens have some important similarities to the 1935 Moore collection. They both show evidence of damage (Fig. 2). They are extremely coarse, the ultimate segments broad and thick-textured, the margins jagged. Morphologically the specimens have the properties of "late fronds," of which similar examples have been detected in a number of *Dryopteris* species. Late fronds are formed as much as 1-3 months after the normal production of leaves, apparently as a result of injury and destruction of the fronds produced at the regular time. This phenomenon has not yet been examined in woodferns, but population samples of Christmas Fern (*Polystichum acrostichoides*) show that their late fronds have thicker texture, larger and fewer pinnae, and incised margins (Wagner, Farrar, and McAlpin, 1970, pp. 22-25). Perhaps the form of the Palmer specimens came about as a result of abnormal late growth following damage from a rock slide, lumbering or grazing in the area, or some other factor which injured or destroyed the normal fronds.

What is the identification of the Palmer *Dryopteris*? Now, as a result of bringing together all of the collections in the herbaria and our field studies, we are able to choose which of the previous suggestions is correct. First, we can eliminate, with fair assurance, several of the alternatives because our plant, in spite of its abundant production of sori and sporangia, is sterile. The spores are abortive, indicating that it is most probably a sterile hybrid. Thus, we can eliminate *D. celsa* and *D. cristata* as identifications. The majority of students of this plant have seen resemblances, however, to one of these species, namely *D. celsa* (W. Palmer) Small, a widespread but generally rare and sporadic eastern American species. The Palmer *Dryopteris* shows resemblances to *D. celsa* in such characters as blade outline, pinna structure, and position of the sori. Of the alternative hybrid combinations, we can eliminate *D. celsa* × *spinulosa* on the basis of frond texture and position of the sori, as well as the fact that *D. spinulosa* is absent at this locality. We can eliminate *D. celsa* × *intermedia* (= *D.* ×*separabilis* Small) on the basis of absence of epidermal glands and position of the sori, and, similarly, the absence of *D. intermedia* at the locality. This leaves us with *D. celsa* × *marginalis*, a striking hybrid, better known by its binomial *D.* ×*leedsii*. For several reasons this identification makes sense: (a) the frond shape and cutting, (b) the slightly "rubbery" texture, (c) the position of the sori, slightly above medial, and (d) the great abundance of *D. marginalis* at the locality. Comparison of the plant with collections from various localities of *D.* ×*leedsii* reveals that it is the same taxon. This, then, vastly increases the known range of this woodfern hybrid to the west.

Figure 2. Specimen from original E. J. Palmer collection, Van Buren Co., Arkansas, March, 1928, *Palmer 33216* (US).

The question immediately arises as to where *D. celsa* is in the locality. So far as we know—and we have made repeated searches for it there—the nearest locality for this parent is 75 miles away. The Log Fern, *D. celsa,* is very rare in the Midwest, and has usually been misidentified as *D. clintoniana* (D. C. Eaton) Dowell, the Northern Broad Swamp Fern. *Dryopteris clintoniana* occurs mainly in the Great Lakes area and New England and is not known south of Wisconsin glaciation. The following are specimens of *D. celsa* we have examined from the nearest localities: MISSOURI: Carter Co., Outlet of Blue Spring tributary to Big Barren Creek, 10 mi. NW of Bennett, *J. A. Steyermark 5333* (MO); the same, juvenile plants, *Steyermark 11858* (MO). ARKANSAS: Lawrence Co., "York Springs" (old York Estate), approximately 3½ mi. S of Imboden [*fide* Demaree], 24 May 1925, *B. C. Marshall 9* (US). Polk Co., Ouachita Mts., N side of Missouri Mt., valley of Big Fork Creek, ca. 1 mi. W of Big Fork, elev. ca. 800 ft., dense, deciduous, rich woods at base of steep, rocky, north-facing slope, along small streams, 12 October 1952, *D. M. Moore, A. McWilliam,* and *H. H. Iltis 52040* (US).

SYNTHESIS OF OUR KNOWLEDGE OF D ×LEEDSII

The history of this taxon is a good example of the gradual increase of understanding that has characterized so many of the hybrid ferns in recent years. Apparently, the first discovery of *D. ×leedsii* was that of the Palmer *Dryopteris* in 1928, but it remained a mystery until the present. In 1931, Arthur N. Leeds discovered a fine population of it near the banks of the Susquehanna River in Maryland, where it was growing with *D. marginalis.* He and all subsequent workers until 1965 interpreted the plant as the hybrid of Goldie's Fern, *D. goldiana* (Hook.) A. Gray, and Marginal Wood Fern, *D. marginalis* (L.) A. Gray. Small (1938, p. 286) confused the Palmer *Dryopteris* with his new species from the Great Dismal Swamp, Virginia, *D. separabilis,* and postulated that it had its ancestry in the mountains and spread to the lowlands, now remaining "in only two outposts, retreats as it were, one the Dismal Swamp, the other the hills of Arkansas." Wherry (1942) decided to give the Susquehanna plant a name, and he honored the discoverer of that colony by naming it for him, *D. ×leedsii.* The full latin diagnosis is as follows: "*Planta hybrida inter Dryopterem goldianam et D. marginalem, folius sempervirentibus, soris medialibus.*" This misinterpretation of its origin continued through 1962, when Stanley Walker (1962b) of the University of Liverpool, published his very important cytological studies of the Susquehanna population. Of the cytotypes found there, he interpreted a fertile tetraploid ("*D. wherryi* F. W. Crane") as the possible form of *D. ×leedsii* in which the chromosome number had doubled, but he conceded that there were problems with this interpretation. Accordingly, in 1963, Wherry and Wagner revisited the Susquehanna locality and discovered that what Crane had named "*D. wherryi*" was, in fact, *D. celsa.* This explained why typical *D. ×leedsii* had been found by Walker to be a triploid, as *D.*

Figure 3. Very broad form of *D.* ×*leedsii* from the type locality, Harford Co., Md., October, 1963, *Wagner and Wherry 63172* (MICH).

celsa is a tetraploid and *D. marginalis*, the other associate, is a diploid. Thus, *D.* ×*leedsii* proved not to be *D. goldiana* × *marginalis*, and this fact was revealed in a publication based on studies in the vicinity of Rochester, N. Y. (Wagner and Wagner, 1965). The following year, the distinctions between *D. celsa* × *marginalis* and *D. goldiana* × *marginalis* were delineated and the latter was designated as *D.* ×*neo-wherryi* (Wagner and Wagner, 1966). One of the curious by-products of this study was the discovery that the spores of *D.* ×*leedsii*, in spite of their high level of abortion, are remarkably capable of germination, with over one-third of a sample actually forming prothallia (Whittier and Wagner, 1971). In the meantime, the new discoveries about *D.* ×*leedsii* encouraged field explorations for it. Not only was it found in 1964 in the vicinity of Rochester, N. Y., but also near Thurmont, Md. the same year. In 1970, a colony was discovered by Wherry and Wagner near Morgantown, Pa. Finally, the Palmer *Dryopteris* was rediscovered after nearly forty years by Taylor, thus making it possible to bring together the whole picture.

We now know of six localities in four states for this taxon, with the Arkansas locality well over 800 miles disjunct. Three of these localities, those marked with asterisks in the enumeration given here, are herewith reported for the first time: NEW YORK — Monroe Co., "Riga Swamp," 1 mi. E of Genesee Co. line along route NY 33A (Mr. Pym's property), low swampy woods, 18 April 1964, *W. H. Wagner* and *F. S. Wagner 64010* (MICH). Genesee Co., Bergen Twp., Pocock Entrance to Bergen Swamp, low, swampy woods, 19 April 1964, *Wagner* and *Wagner 64018* (MICH). PENNSYLVANIA — *Berks Co., 0.5 mi. NE Joanna Furnace (ca. 4 mi. NE Morgantown), on rocky seepage slope in woods above road, 5 December 1970, *W. Wagner* and *E. T. Wherry 70519* (MICH). MARYLAND — *Frederick Co., 1.4 mi. W of Thurmont, just S of road along Hunting Creek (just inside recreation area) on rocky seepage slopes, 10 March 1964, *W. Wagner, C. V. Morton,* and *D. B. Lellinger 64005* (MICH). Harford Co., N bank of Susquehanna River near Rock Run, rocky slope 2 mi. N of Lapidum, 26 October 1963, *W. Wagner* and *E. T. Wherry 63172,* TYPE LOCALITY (MICH). ARKANSAS — *Van Buren Co., near Shirley, numerous collections cited above in text, plus *Carl Taylor* and *Jerry Taylor 2597* (SIU), *Paul L. Redfearn* and *Alice Redfearn 29403* (SMS), *Wagner* and *Wagner 74164* (MICH).

We can summarize our knowledge of *D.* ×*leedsii* in the following way: An interspecific hybrid woodfern growing usually with both parents, *D. celsa* and *D. marginalis*, rarely with only one parent, in rich, damp soil of low, swampy forests or on rocky, usually springy slopes. A magnificent, tall, and decorative fern combining the characters of its parents, and differing from *D. goldiana* × *marginalis* (= *D.* ×*neo-wherryi*) in: (1) being more evergreen; (2) having somewhat more numerous pinnae, these (3) more triangular, and (4) more reduced at the blade base, and (5) having more medial sori. The habitat is somewhat more moist for *D.* ×*leedsii*.

Cytogenetically it is triploid, rather than diploid (Wagner and Wagner 1966, pp. 133-136, figs. 5-7). The plant is rare and known at present from only a few localities in the region New York to Maryland, with an isolated locality in Arkansas. Reproduction is apparently entirely by rhizome proliferation, although some evidence exists for spore dispersal since, as previously mentioned, an unusually large number of otherwise abortive spores are capable of germination.

The Arkansas locality of *D.* ×*leedsii* has special interest because it is so separated from the rest of the known stations far to the east, because one of the parents is missing at the locality, and because what is apparently the same colony has persisted there for nearly a half-century. Perhaps at this, or one of the other localities, *D.* ×*leedsii* may double its chromosome complement, thus becoming a sexually reproducing fern. Its cytogenetic constitution may be expressed, according to our present knowledge, as GLM, where G = *D. goldiana* genome, L = *D. ludoviciana* genome, and M = *D. marginalis* genome (the evidence for this interpretation is summarized in Wagner, 1970). If automatic chromosome doubling occurred this would presumably form an allohexaploid with the cytogenetic constitution of GGLLMM with normal pairing and spore production.

REFERENCES

BRANNER, J. C. and F. V. COVILLE. 1891. A list of the plants of Arkansas. Annual report for 1888. Arkansas Geol. Survey 4: 155-242. Little Rock, Arkansas.

BUCHHOLZ, JOHN T. 1924. Notes on Arkansas pteridophyta. Amer. Fern J. 14: 33-38.

——— and E. J. PALMER. 1926. Supplement to the catalog of Arkansas plants. Trans. Acad. Sci. St. Louis 25: 91-155.

DEMAREE, DELZIE. 1943. A catalogue of the vascular plants of Arkansas. Taxodium 1: 1-88.

EVANS, A. MURRAY and W. H. WAGNER, JR. 1964. *Dryopteris goldiana* × *intermedia*—a natural woodfern cross of noteworthy morphology. Rhodora 66: 255-266.

HARVEY, F. L. 1881. Ferns of Arkansas. Bot. Gaz. 6: 189-190; 213-215.

LESQUEREUX, LEO. 1860. Botanical and paleontological report on the geological state survey of Arkansas. Rep. Second Geol. Survey of Arkansas pp. 295-399. Philadelphia, Pennsylvania.

McKELVEY, S. D. 1955. Botanical exploration of the Trans-Mississippi West. 1790-1850. Arn. Arb., Jamaica Plain, Mass. pp. 164-187.

MOORE, DWIGHT M. 1940a. *Selaginella rupestris* (L.) Spring in Arkansas. Amer. Fern J. 30: 50-53.

———. 1940b. Arkansas pteridophyta. Amer. Fern J. 30: 105-119.

———. 1941. Some noteworthy fern communities of Arkansas. Amer. Fern J. 31: 63-71.

PALMER, E. J. 1924. Two interesting ferns from Arkansas. Amer. Fern J. 14: 39-41.

PALMER, WILLIAM. 1899. Ferns of the Dismal Swamp, Virginia. Proc. Biol. Soc. Washington 13: 61-70.

———. 1902. The log fern. The Fern Bulletin 10: 37-41.

SMALL, JOHN KUNKEL. 1938. Ferns of the Southeastern States. Science Press, Lancaster, Pennsylvania. 517 p.

SCULLY, F. J. 1937. Ferns of the Hot Springs National Park. Amer. Fern J. 27: 59-62.

———. 1939. Ferns of Hot Springs National Park and vicinity. Natural History Journal 5: 1-37.

THOMAS, R. DALE, W. H. WAGNER, Jr. and MICHAEL R. MESLER. 1974. Log Fern (*Dryopteris celsa*) and related species in Louisiana. Castanea 38: 269-274.

UNDERWOOD, LUCIEN MARCUS. 1908. Our native ferns and their allies. 6th ed., revised. Henry Holt and Co., New York. i-x, 1-158 p.

WAGNER, W. H., JR. 1970. Evolution of *Dryopteris* in relation to the Appalachians. *In*

Holt, Perry. C. (editor) "The distributional history of the biota of the southern Appalachians. Part II: Flora." Virginia Polytechnic Inst. and State Univ. Research Division Monograph 2: 147-192.

. and KATHERINE LIM CHEN. 1965. Abortion of spores and sporangia as a tool in the detection of *Dryopteris* hybrids. Amer. Fern J. 55: 9-29.

, D. R. FARRAR and B. W. McALPIN. 1970. Pteridology of the Highlands Biological Station Area, southern Appalachians. Jour. Elisha Mitchell Sci. Soc. 86: 1-27.

. and FLORENCE S. WAGNER. 1965. Rochester area log ferns (*Dryopteris celsa*) and their hybrids. Proc. Rochester Acad. Sci. 11: 57-71.

. and FLORENCE S. WAGNER. 1966. Pteridophytes of the Mountain Lake Area, Giles Co., Virginia: Biosystematic Studies, 1964-1965. Castanea 31: 121-140.

, FLORENCE S. WAGNER and DALE J. HAGENAH. 1969. The log fern (*Dryopteris celsa*) and its hybrids in Michigan. Michigan Botanist 8: 137-145.

WALKER, STANLEY. 1959. Cytotaxonomic studies of some American species of *Dryopteris*. Amer. Fern J. 49: 104-112.

. 1962a. Further studies in the genus *Dryopteris*: The origin of *D. clintoniana*, *D. celsa*, and related taxa. Amer. J. Bot. 49: 497-503.

. 1962b. The problem of *Dryopteris leedsii*. Amer. J. Bot. 49: 971-974.

. 1969. Identification of a diploid ancestral genome in the *Dryopteris spinulosa* complex. British Fern Gaz. 10: 97-99.

WHERRY, E. T. 1942. A woodfern hybrid deserves a name. Bartonia 21: 2.

WHITTIER, DEAN P. and W. H. WAGNER, JR. 1971. The variation in spore size and germination in *Dryopteris* taxa. Amer. Fern J. 61: 123-127.

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REINSTATEMENT OF THE GENUS TIQUILIA (BORAGINACEAE: EHRETIOIDEAE) AND DESCRIPTIONS OF FOUR NEW SPECIES

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The genus *Coldenia* L. sensu Gray (1862) and Johnston (1924) presently comprises twenty nine taxa which, with one exception, occur in North America and South America. The type species, *C. procumbens* L., the only Old World taxon, is found mainly in southeastern and southwestern Asia and to a lesser extent in Africa and Australia. This paper is presented in anticipation of a forthcoming monograph.

Earlier workers displayed a reluctance to place the New World taxa in the genus *Coldenia*, describing such genera as *Eddya* (Torrey and Gray, 1857), *Galapagoa* (Hooker, 1847), *Ptilocalyx* (Torrey and Gray, 1857), *Stegnocarpus* (Torrey and Gray, 1857), *Tiquilia* (Persoon, 1805), and *Tiquiliopsis* (Heller, 1906). Gray (1862), dealing with only eight species, combined *Eddya, Ptilocalyx, Stegnocarpus* and *Tiquilia* with *Coldenia,* but noted, "Those who regard the reduction here foreshadowed as too great, might be better satisfied with three genera, viz. *Coldenia, Ptilocalyx,* and *Tiquilia.*"

Recent examination of all taxa has shown that the genus *Coldenia* as it stands contains two groups with distinct characters and without intermediates. These groups are distinct geographically as well as morphologically. I therefore am reinstating the New World genus *Tiquilia* Pers., giving a well-marked, cohesive New World genus and a monotypic Old World genus. The two genera are distinguished by the following characters.

TABLE 1. Contrasting characters of *Coldenia* L. and *Tiquilia* Pers.

Coldenia L.	*Tiquilia* Pers.
1. Habitat forest and woodland, riverbanks and dried rice fields, Old World.	1. Habitat xeric regions, New World.
2. Annual herbaceous weed.	2. Perennial, woody, or herbaceous with a woody base, not a weed.
3. Adventitious roots.	3. No adventitious roots.
4. Leaf markedly asymmetrical.	4. Leaf symmetrical.
5. Flowers solitary, extra-axillary, not subtended by bracts.	5. Flowers solitary or in clusters, axillary or subtended by bracts.
6. 4 sepals, 4 petals, 4 stamens.	6. 5 sepals, 5 petals, 5 stamens.

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Following are the necessary new combinations in the genus *Tiquilia* Pers., Synopsis Plantarum 1:157. 1805. TIQUILIA **atacamensis** (Phil.) A. Richardson, comb. nov., *Coldenia atacamensis* Phil., Florula Atacamensis 211. 1860. TIQUILIA **canescens** (DC.) A. Richardson, comb. nov., *Coldenia canescens* DC., Prodromus Systematis Naturalis 9:559. 1845. TIQUILIA CANESCENS var. **pulchella** (I. M. Johnst.) A. Richardson, comb. nov., *Coldenia canescens* var. *pulchella* I. M. Johnst., J. Arnold Arbor. 20:379. 1939. TIQUILIA **conspicua** (I. M. Johnst.) A. Richardson, comb. nov., *Coldenia conspicua* I. M. Johnst., J. Arnold Arbor. 16:183. 1935. TIQUILIA **cuspidata** (I. M. Johnst.) A. Richardson, comb. nov., *Coldenia cuspidata* I. M. Johnst., Proc. Calif. Acad. Sci. 12:1137-1139. 1924. TIQUILIA **darwinii** (Hook. f.) A. Richardson, comb. nov., *Galapagoa darwinii* Hook. f., Trans. Linn. Soc. London 20: 196, 197. 1847. TIQUILIA **elongata** (Rusby) A. Richardson, comb. nov., *Coldenia elongata* Rusby, Description of Three Hundred New Species of South American Plants. Rusby. New York. p. 107. 1920. TIQUILIA **ferreyrae** (I. M. Johnst.) A. Richardson, comb. nov., *Coldenia ferreyrae* I. M. Johnst., J. Arnold Arbor. 37: 296-298. 1956. TIQUILIA **fusca** (Hook. f.) A. Richardson, comb. nov., *Galapagoa fusca* Hook. f., Trans. Linn. Soc. London 20:196. 1847. TIQUILIA **gossypina** (Woot. and Standl.) A. Richardson, comb. nov., *Eddya gossypina* Woot. and Standl., Contr. U.S. Natl. Herb. 16:164. 1913. TIQUILIA **grandiflora** (Phil.) A. Richardson, comb. nov., *Coldenia grandiflora* Phil., Anales Mus. Nac. Hist. Nat. Chile 2:55. 1892. TIQUILIA **greggii** (T. and G.) A. Richardson, comb. nov., *Ptilocalyx greggii* T. and G., Senate Executive Doc. No. 78, 33rd Congr., 2nd Sess. Vol. 2:p. 170, Plate 8. 1857. TIQUILIA **hispidissima** (T. and G.) A. Richardson, comb. nov., *Eddya hispidissima* T. and G., Senate Executive Doc. No. 78, 33rd Congr., 2nd Sess. Vol. 2:pp. 170, 171. Plate 9. 1857. TIQUILIA **latior** (I. M. Johnst.) A. Richardson, comb. et stat. nov., *Coldenia hispidissima* var. *latior* I. M. Johnst., Contr. Gray Herb. 68:92. 1923. The above change is made after examination of 113 collections of Johnston's *C. hispidissima* var. *latior*. It is separated geographically from *Tiquilia hispidissima* and is easily distinguished from that species by its larger, broader leaves with densely ciliate petioles, and its larger, obpyriform nutlets. TIQUILIA **litoralis** (Phil.) A. Richardson, comb. nov., *Coldenia litoralis* Phil., Florula Atacamensis 211. 1860. TIQUILIA **mexicana** (Wats.) A. Richardson, comb. nov., *Coldenia mexicana* Wats., Proc. Amer. Acad. Arts 18:119, 120. 1883. TIQUILIA **nesiotica** (J. T. Howell) A. Richardson, comb. nov., *Coldenia nesiotica* J. T. Howell, Proc. Calif. Acad. Sci. (4) 22:237. 1941; *(C. conspicua* J. T. Howell, Proc. Calif. Acad. Sci. (4) 22:105, 106. 1937, not *C. conspicua* I. M. Johnst., J. Arnold Arbor. 16:183. 1935). TIQUILIA **nuttallii** (Benth.) A. Richardson, comb. nov., *Coldenia nuttallii* Benth. *in* Hooker, W. J., Hooker's J. Bot. Kew Gard. Misc. 3:296. 1851. TIQUILIA **palmeri** (Gray) A. Richardson, comb. nov., *Coldenia palmeri* Gray, Proc. Amer. Acad. Arts 8:292, 293. 1870. TIQUILIA **paronychioides** (Phil.) A. Richardson, comb. nov., *Coldenia paronychioides* Phil., Anales Mus. Nac. Hist. Nat.

Chile 2:55. 1892. TIQUILIA **plicata** (Torr.) A. Richardson, comb. nov., *Tiquilia brevifolia* var. *plicata* Torr. In Emory, Bot. United States and Mexican Boundary Survey 2:136. 1859; (*Coldenia plicata* Cov., Contr. U. S. Natl. Herb. 4:163. 1895). TIQUILIA **purpusii** (Brandeg.) A. Richardson, comb. nov., *Coldenia purpusii* Brandeg., Univ. Calif. Publ. Bot. 4:186. 1911. TIQUILIA **simulans** (I. M. Johnst.) A. Richardson, comb. nov., *Coldenia simulans* I. M. Johnst., J. Arnold Arbor, 37:298, 299. 1956.

Two new species from gypseous areas in Mexico, and two new species from Peruvian deserts are here described.

TIQUILIA **tuberculata** A. Richardson, sp. nov.

Suffrutex parvus nodosus tortus ad 2.0 cm altus 3.0 cm diametro caudice ad 0.8 cm diametro. Caules hornotini villosi lanatique vel moderate villosi. Rami brevissimi fragiles foliiferes. Folia fasciculata linearia vel oblonga 2.8-4.5 mm longa 0.6-1.2 mm lata margine revoluta; laminae virides setis crassis 0.8-2.2 mm longis raro paululum cinereae minute hispidaeque pilis ca 0.2 mm longis; petiolus transectione elliptica vel parum rectangulari glabrus vel raro paululum villosus lineis 2 lateralibus ciliatis. Flores axillares solitarii. Calyx 2.0-2.5 mm longus ciliatus extus glabrus intus duabus tertiis partibus distalibus pilis adpressis setisque rigidis paucis 0.5 mm longis. Mericarpia 1-4 ovoidea nigra tuberculis albis 1.0-1.1 mm longis 0.5-0.6 mm crassis.

TYPE: MEXICO: Nuevo Leon: Km. 100 on highway from Monterrey to Monclova, gypseous soil, 28 Aug. 1973, *Alfred Richardson 2181.* (Holotype: TEX. Isotype: MEXU).

Distribution: Known only from the type locality and nearby gypseous areas ca. 20 km. distant in Nuevo Leon.

The specific epithet refers to the unusual tuberculate (as defined by Stearn, 1966) ornamentation of the nutlets. No other species of *Tiquilia* has this condition.

Tiquilia tuberculata is in section *Eddya* Gray, and is most closely related to *T. gossypina.* It differs from that species in its tuberculate nutlets, unappendaged corollas, and the usually glabrous condition of the abaxial surfaces of the petioles.

TIQUILIA **turneri** A. Richardson, sp. nov.

Suffrutex nodosus tortus tumuliformis ad 9.0 cm diametro. Caudex ad 10.0 cm diametro. Caules hornotini villosi lanatique vel moderate villosi. Rami brevissimi fragiles foliiferes in plantis veteribus congestissimis. Folia fasciculata linearia oblongave 2.5-5.5 mm longa 0.6-1.5 mm lata margine revoluta utrinque dense villosa cinereaque vel paululum villosa viridiaque setisque 0.7-1.7 mm longis; petioli transectione ellipticis vel parum rectangularibus omnino dense villosi ciliative. Flores axillares solitarii. Calyx 2.0-3.0 mm longus dense villosus ciliatusve intus pilis subtilibus adpressis in quoque lobo apice setis 1-2 rigidis 0.7-1.7 mm longis. Mericarpia 1-2 ovoidea nitida nigra laeviaque vel subtiliter aspera 0.8-1.5 mm longa 0.6-0.8 mm lata.

TYPE: MEXICO: Coahuila: 20 km. south and 3 km. west of Cuatro Ciénegas, in gypsum dunes, 29 June 1971, *Alfred Richardson 1595.* (Holotype: TEX. Isotype MEXU).

Distribution: Two populations, separated by about 160 kilometers, are known: The type locality, and another gypseous area about 100 kilometers northwest of Monterrey, Nuevo Leon, Mexico.

The species is named for B. L. Turner who first collected this taxon and called it to my attention.

Tiquilia turneri is in section *Eddya* Gray, and is the only member of the section to have nutlets with thin and relatively soft and smooth pericarps. It is most closely related to *T. gossypina* and is distinguished from that species by its smaller leaves and flowers, the shrubby habitat and often reduced stem internodes, and the nutlet characters mentioned above.

TIQUILIA **hunteri** A. Richardson, sp. nov.

Suffrutices semierecti ad 4.0 dm. diametro; caudices ad 5.0 mm. crassi. Laminae foliorum anguste ovatae 4.0-6.0 mm. longae 2.0-2.5 mm. latae margine saepe crenatae profunde plicatae supra pubescentes setis ad 1.1 mm. longis antrorse inclinatis subtus pilis effusis pro parte maxima secus nervos, nervis lateralibus utroque costae latere 2-3(-4) extremis sinusialibus; petioli filiformes 3.0-4.5 mm. longi. Corollae 5.5-6.5 mm. longae azureáe. Stamina inaequalia inclusa, filamentis brevibus ad 0.3 mm. longis in 3 altitudinibus affixis, nervis substaminalibus basi anguste alatis. Mericarpia 4 sphaeroidea 0.7-0.8 mm. diametro. Chromosomatum numerus $n = 14$.

TYPE: PERU: Arequipa: Km. 714 S of Lima, between Chala and Camaná, 8 Apr. 1973, *Richardson 2106.* (Holotype TEX. Isotypes to be distributed).

Distribution: Known only from the type locality.

The species is named for John H. Hunter of Brownsville, Texas, who has for many years encouraged and aided young students interested in the biological sciences.

T. hunteri is in section *Sphaerocarya* I. M. Johnst. and is most closely related to *T. elongata* and *T. litoralis.* The species are compared in Table 2.

TIQUILIA **tacnensis** A. Richardson, sp. nov.

Herbae procumbentes tegetes formantes 5.0 dm. diametro; caudices ad 10.0 mm. crassi. Laminae foliorum ovatae 4.5-5.5 mm. longae 3.0-3.5 mm. latae margine integrae plicatae supra sparse pubescentes pilis ad 0.3 mm. longis setisque inclinatis ad 0.7 mm. longis subtus dense pubescentes pilis effusis vel adpressis ad 0.5 mm. longis, nervis lateralibus utroque costae latere 3 (vel 2); petioli filiformes 3.0-4.0 mm. longi. Corollae 5.0-6.0 mm. longae exappendiculatae limbis caeruleis faucibus flavis. Stamina subaequalia 1.5-2.5 mm. exserta aequaliter tubo adnata. Mericarpia 4 sphaeroidea 1.0-1.1 mm. alta 0.9-1.2 mm. diametro. Chromosomatum numerus $n = 16$.

TYPE: PERU: Tacna: Ca. 10 km. S of Camiara, 70 km. N of Tacna, 13 Apr. 1973, *Richardson 2130* (Holotype TEX. Isotypes to be distributed).

TABLE 2

CONTRASTING CHARACTERS OF TIQUILIA TACNENSIS, T. LITORALIS, T. ELONGATA, AND T. HUNTERI

	T. tacnensis	*T. litoralis*	*T. elongata*	*T. hunteri*
1. Habitat.	1. Coastal.	1. Coastal.	1. Inland, medium altitudes.	1. Coastal.
2. Habit.	2. Prostrate.	2. Prostrate.	2. Semi-erect or prostrate.	2. Semi-erect.
3. Leaf Blade.				
a. Shape.	3a. Ovate.	3a. Ovate.	3a. Narrowly ovate lanceolate, or narrowly obovate.	3a. Narrowly ovate.
b. Length.	3b. 4.5-5.5 mm.	3b. 3.5-8.0 mm.	3b. 10.0-23.0 mm.	3b. 5.0-6.0 mm.
c. Lateral Veins.	3c. 3 pr.	3c. 2-3 pr.	3c. 3-4 pr.	3c. 2-3 pr.
d. Margin	3d. Entire.	3d. Entire.	3d. Crenate.	3d. Crenate.
4. Corolla.				
a. Color.	4a. Sky-blue	4a. Sky-blue to milk-white.	4a. Blue.	4a. Blue.
b. Length.	4b. 5.0-6.0 mm.	4b. 4.5-8.0 mm.	4b. 5.5-12.2 mm.	4b. 5.5-6.5 mm.
5. Stamens.	5. Exserted.	5. To limb.	5. Included.	5. Included.
6. Nutlet Size.	6. 0.9-1.2 mm.	6. 0.8-1.1 mm.	6. 0.8-0.9 mm.	6. 0.7-0.8 mm.
7. Chromosome Number.	7. $n = 16$.	7. $n = 15$	7. $n = 16$	7. $n = 14$.

Distribution: Peru, southern Tacna, near the Chilean border. One large uniform population is known, extending for ca. 30 kilometers.

The specific epithet refers to the department of Tacna, Peru, to which this species is endemic.

T. tacnensis is in section *Sphaerocarya* I. M. Johnst. and is most closely related to *T. atacamensis*, having similar flavonoid chromatograph pattern and similar calyxes and general pubescence. It is distinguished from that species by its usually more slender and elongate internodes, its smaller, ovate leaves with usually 3 pairs of lateral veins, its sky-blue unappendaged corollas with slightly longer stamens, and its spheroid, smaller nutlets with slightly larger collicula.

T. tacnensis is also closely related to *T. litoralis*, differing in flavonoid chromatograph pattern, chromosome number, leaf blades with usually 3 pairs of lateral veins, paucity or absence of long stiff bristles on the calyxes, and its nutlets with a protruding lip above the attachment scar and with slightly larger collicula. There are also some similarities to *T. elongata* and *T. hunteri*. The four species are contrasted in Table 2.

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REFERENCES

GRAY, A. 1862. Notes upon a portion of Dr. Seeman's recent collection of dried plants gathered in the Feegee Islands. In Proc. Amer. Acad. Arts 5: 340, 341.

HELLER, A. 1906. Botanical exploration in California. Muhlenbergia 2: 239.

HOOKER, J. D. 1847. Dr. J. D. Hooker's enumeration of the plants of the Galapagos Archipelago. In Trans. Linn. Soc. London 20: 196, 197.

JOHNSTON, I. M. 1924. A tentative classification of the South American *Coldenias*. In Contrib. Gray Herb. 70: 55-61.

PERSOON, C. H. 1805. Synopsis Plantarum 1: 157.

STEARN, W. T. 1966. Botanical Latin. Thomas Nelson Ltd. London. 566 pp.

TORREY, J. and A. GRAY. 1857. Reports of explorations and surveys for a railroad route from the Mississippi River to the Pacific Ocean. In Senate Executive Document No. 78, 33rd Congress, 2nd Session, Vol. 2: 169-171, plates 7-9.

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A TREATMENT OF DELPHINIUM FOR ALABAMA AND TENNESSEE

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During field work toward a flora of Alabama and Middle Tennessee I have come across several populations in northern Alabama of what appears to be a new species of *Delphinium*, a species showy even in a genus well known for handsome examples. *Delphinium* in North America according to Professor Ewan (1945) comprises 79 species, with most occurring west of the Mississippi in the U. S., or in Mexico. A scant five, and this including an introduced european, *D. ambiguum* L. have been known previously for the Alabama-Tennessee area. An attempt is made here to present a synopsis of *Delphinium* for Alabama-Tennessee, so as to place a sixth "new" species in context.

The descriptions and keys, while somewhat detailed, are in no way intended to serve in a broad regional-revisional sense; they are based mostly on examples gotten from the two-state area. For a thorough, accurate rendition of the genus for North America the fine work done by Joseph Ewan (Univ. Colorado Studies 2, No. 2, pp. 55-244, 1945) is recommended, together with Ernst Huth's monograph of the world species (1895).

For the purpose of comparing flower parts of the six species, flowers from each were boiled in water and glycerine, spread and drawn. These drawings, together with outlines of blades of lower stem leaves, have been executed free-hand.

Field work toward this paper was supported largely by a research grant to the author from the National Science Foundation (NSF GB-6688X).

MORPHOLOGY

ROOTSTOCK—Of the six species treated here, *D. ambiguum* is a taprooted annual, *D. exaltatum* has the caudex produced below into a cluster of elongated, somewhat fleshy fibrous-branched taproots, *D. alabamicum* (the new species) and *D. tricorne* have slender, weak stem bases articulated to a fascicle of short-fusiform tuberous roots, and the remaining species have non-tapering stems grading directly to a stoutish caudex, this usually producing subfasciculate, short-tuberous roots.

STEMS—The stems of our *Delphinium* are typically single and erect from the rootstock, tend to be hollow (quite soft-fistulose in *D. tricorne*), and are trichomiferous at least in the inflorescence. Nodes are close-set proximally, gradually or abruptly more distant distally. Branching is not usual below the inflorescence.

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LEAVES—The leaves are both basal and cauline, the former long-petiolate, arising from the rootstock or caudex to form strong rosettes, these leaves together with those of the lower stem usually yellowing or withering by anthesis. The petioles narrow abruptly above from broadly clasping bases, those of rosettes and lower stems longer than the leaf blades, progressively shortening upward on the stem. The leaf blades are in outline mostly broad, ranging from broadly ovate through suborbicular or semicircular to reniform, and are in the five perennials deeply palmatisect into 3-5 primary segments. These are usually cuneate-based, themselves flabellately or pinnately dissected. Width and length of segments varies quite widely within each species, often on the same plant, so that a fairly wide series of examples has to be examined to establish descriptive parameters. Leaf surfaces range from nearly smooth to copiously pubescent.

INFLORESCENCE—The inflorescence in our *Delphinium* is mostly a terminal, indeterminate raceme with the number of flowers ranging widely within species and seeming to be dependent on general vigor of the plant. More vigorous plants will often produce some branches from lower inflorescence nodes, these terminating in racemes. A paniculate inflorescence is sometimes approached in that lower pedicels may themselves produce a few flowers. The pedicels themselves are accrescent. However the usual inflorescence habit is for the ascending to nearly erect pedicels to present flowers in a cylindrical, "spicate" raceme with the flowers at anthesis approximate toward its tip, becoming more distant as the internodes elongate in the aging inflorescence. Each pedicel bears at its base a bract, all but the lowermost usually linear, upward sometimes an additional bract or two, then subterminally a pair of bracteoles.

FLOWER—The flowers of *Delphinium* are developed on a fleshy, convex torus, this facing somewhat away from the axis by a terminal bend in the pedicel tip.

There are 5 sepals, the uppermost largest, longest, produced into a prominent, narrowly conic, elongate slightly curvate spur, this horizontally or upwardly oriented, pointing backward, and from its semicircular orifice producing an upwardly-bent broadish blade. The other 4 sepals are comprised of two somewhat spreading lateral pairs which are subequal in length, but with the upper pair broader, more asymmetrical, usually with the upper edge more rounded than the lower. These are usually of the same color as the spur sepal, the calyx in combination the largest, showiest part of the whole flower. Sepal traces are usually 3, but these ramify shortly above entry into the sepals which often show 5 strong longitudinal veins in the blade, these strongly anastomosing subapically. In 3 of the native species this subapical area is produced into a pouchlike concavity (*D. carolinianum, D. vimineum, D. exaltatum*). In the rest it is essentially flat, or but slightly produced and evident more as a deeper colored "patch." While the lateral sepals of the perennials are essentially of an oblong or ovate outline and

broad-based, in *D. ambiguum*, the porportionately broader sepals have short but distinct claws. Pubescence of sepals is essentially confined to the outer surfaces and ranges from a fine, usually incurved, puberulence to villous or even strigillose, and is most strongly produced in a broad, median-longitudinal zone.

The petals of the perennial species treated here are in 2 sets of 2. The upper pair produce spurs and are connivent, these spurs enclosed by the spur of the sepal and of a similar length though much narrower outline. Only the spur bases are tubular-conic, their orifices gradually oblique, gradually flattening and widening distally, firm, the edges involuted, the upper slightly curvate, continuous with the spur, the lower produced above the petal attachment into a long, shallow sinus, this bordered at each end by a callus-thickened, broad lobe, the terminal portion an asymmetrically ovate, rather fleshy blade, the apex of which ranges from rounded to sharply emarginate or bifid. These petal blades project up under the spur sepal blade and forward, projecting slightly beyond the sepal apex, and are convergent keel-like along their upper edges, thus forming a broad inverted "V" in front view. The petal traces are single, ramifying just above their entry into 3, 2 of which bend back into the spur, thence upward along the upper margin of the petal into its blade, the third bending directly upward into the blade (see petal drawings). These spur petals are essentially smooth save for minute papillosity or puberulence internally in the spurs (the nectariferous zone) together with, in some cases, longer trichomes on the petal blades. Pigments appear confined to the blades.

The lower pair of petals is clawed, about the length of the lateral sepals and frequently with blades of the same color. The claw bases are short-tubular, strongly folded-keeled, and bear on their upper side proximally an erect or ascending distinctive spur; upwardly the claw twists and is also geniculate apically. Thus the ovate, usually deeply bifid petal blades are twisted outward and somewhat bent downward, with the upper surfaces facing outward in the open flower. In *D. carolinianum* and *D. virescens* especially, these same blades are produced upward into two submarginal longitudinally oriented, fleshy, subalar processes toward their bases. On and in between these zones is a medially-longitudinally oriented, usually villous, beard.

In *D. ambiguum* a very different morphology of the corolla is manifest. The upper petal pair have become fused into a single spur and blade. The spur orifice is even, and from its inner edge between the petal attachment points is a prominent, erect ligule. The blade is suberect, most of its area comprised of two strong auricles together with a broad, very emarginate, terminal lobe. In this species there are no claw petals.

STAMENS—The stamens are rather uniform in character. In all six species they are numerous, set in close spiral, project forward, and are sigmoidly bent. The filaments are strongly flattened and scarious proximally. In *D.*

ambiguum the filament margins converge rather abruptly just above the middle, while in the remainder they gradually converge. Scattered fine hairs are borne on filaments of *D. exaltatum, D. carolinianum, D. virescens, D. ambiguum.* The anthers are basifixed, broadly ellipsoidal, mostly with locule backs smooth, but in a few cases these also with a scattering of short trichomes.

CARPELS—In our natives, the carpels are usually 3, erect and roughly parallel on the torus, the ovaries usually narrowly lanceovoid and tapering gradually into the slender styles, these terminally stigmatose. In *D. ambiguum* but one carpel is produced, the style is shorter, the stigma is broader, flatter, somewhat folded.

FRUIT—All species produce follicles, these subcylindrical or slightly compressed laterally, more or less strongly raised-venose, variously pubescent. Styles harden and persist as beaks on the fruit.

SEED—Seeds of all species treated here are wedge-shaped, truncate, somewhat prismatic, longitudinally 3-4-angled, and are mostly 2.0-2.5 mm long. The surface of seeds of *D. albamicum, D. tricorne* is finely hairy, irregularly and sparingly low-ridged, apically somewhat invaginated. In *D. exaltatum* it is strongly longitudinally wing-angled. In *D. carolinianum, D. virescens, D. ambiguum,* it is produced outward into numerous, horizontally or diagonally oriented, thinnish, lustrous scales.

Ewan (l.c., p. 72) presents a list of characters contrasted for "primitive" and "more advanced" in the genus. In this list it is noted that a plant which has clustered-tuberous (grumose) rootstocks, smooth foliage, mostly basal leaves which are green and functional at anthesis, of 5 entire or little divided primary lobes, non-glandular pubescence, a relatively few-flowered inflorescence (this a raceme), which has the lateral or lower petal blades entire or emarginate, puberulent, and which has triquetous, wingless seeds smooth with firm, opaque outer coats would be considered more primitive. Of our species *D. tricorne* satisfies more of these criteria than do any others, with *D. alabamicum* next in order. These two species then belong in his series IV, the "Tuberiform" series. In contrast to these primitive character aspects would be plants with roots rhizomatous, more fibrous, with herbage of mainly cauline leaves, these withering and dry at anthesis, and blades of 5 pinnatifid to dissected primary divisions, the foliage more pubescent, even pilose, sometimes glandular. The inflorescence would be many-flowered, a panicle or dense spike. The lateral petal blade would be shallowly or deeply bifid, long-hairy. Seeds would be ribbed, papillate or scaly, the outer coats loose; seed angles would be distinctly winged. *D. exaltatum,* (Series IX, the Inornate Series), and *D. carolinianum, D. virescens* (Series XII, the Spiciform Series) in the classification adopted by Ewan would be more advanced.

TAXONOMY

Key to *Delphinium* of Alabama and Tennessee

1. The plants annual, from taproots; petals comprised of but 1, fused, spurred member; carpels 1/flower; leaves with segments narrowly linear to filiform. . . . . 1. *D. ambiguum* L.
1. The plants perennial, from caudices or from clusters of fusiform-tuberous roots; petals 4, 2 spurred; carpels 3/flower; leaves with segments linear or broader.
   2. Stems strongly tapering into fascicles of tuberous roots; racemes with pedicels spreading-ascending, the flowers at anthesis well separated, mostly 2-3 cm broad; seeds with outer coat tight, the ridges rounded, the surface finely pubescent; sepal tips with subapical pouch poorly developed or not evident.
      3. Plants mostly between 7 and 10 dm tall; pedicels and upper part of stem with an incurved puberulence mixed with longer, spreading hairs; flowers 2.5-3.0 cm broad, deep blue-purple; follicles spreading-ascending; limestone prairies and glades. . 2. *D. alabamicum* Kral.
      3. Plants rarely taller than 4 dm; pedicels and upper part of stem less pubescent, stems strongly fistulose; flowers 2.0-2.5 cm broad, blue-violet to nearly white; follicles spreading at maturity; rich, usually calcareous, woodlands. . . . . 3. *D. tricorne* Michx.
   2. Stems but slightly if at all tapering into thicker, erect caudices, these branching below into thickened roots, or subtended by close-set, fusiform tubers; racemes with pedicels more ascending, thus inflorescence narrower, the flowers at anthesis seldom broader than 2.0 cm; seeds longitudinally winged along the angles or with numerous, transversely oriented squamellae; sepal tips with prominent, subapical "pouch."
      4. Principal lobes of larger leaves showing, on lower surface, 1 strong median nerve and at least a pair of prominent lateral nerves; pubescence of pedicels and of upper part of stem short-incurved; follicle bodies 1 cm long or less; seed longitudinally winged along the angles; flowers pale, dull blue. . . . . 4. *D. exaltatum* Ait.
      4. Principal lobes of larger leaves narrower, the lower surface showing only a strong median nerve; pubescence of pedicels and upper part of stem mostly spreading-strumose; follicle bodies 1.5 cm long or more; seed with numerous transversely oriented scales; flowers bright blue or near white.
         5. Flowers blue or bluish. . . . . 5. *D. carolinianum* Walt.
         5. Flowers white, greenish-white, or tinged with blue or lavender, in any event never bright blue. . . . . 5. *D. virescens* Nutt.

1. DELPHINIUM AMBIGUUM L., Sp. Pl. ed. 2, 749. 1763., Fig. 1.

D. *ajacis* sec. J. Gay, Desmoulins (at. Dordogne 12 (1840).

Taprooted annual, the stem usually solitary, erect, terete, up to 1 m tall, retrorsely puberulent proximally, smoothish medially, antrorsely puberulent distally, the nodes rather closely spaced the length of the stem. Lowest leaves withering by flowering time, of those present the lowest largest and longest-petioled, the petioles spreading-ascending-puberulent, the blades mostly ovate to suborbicular, 3-pinnately dissected into narrowly linear to filiform,

puberulent secondary and tertiary segments, the tips of which are acute, callused, those of mid and upper stems becoming short-petioled or sessile, ternately and then pinnately divided, mostly overlapping (the stems thus appearing quite leafy). Inflorescence a simple, spicate raceme, or plants branching, each branch terminating in a spicate raceme, the flowers numerous and overlapping on puberulent, ascending pedicels shorter than the flowers, each pedicel subtended by a linear to ternate bract and distally bearing a pair of puberulent bracteoles. Perianth segments ranging from deep blue-violet through pale blue to pink or white. Spur sepal ca. 2.5 cm long, the spur ca. 1.5 cm long, the blade broadly to oblong to ovate, the veins converging toward the short-acuminate apex, these closely anastamosing, forming a greenish-yellow pouch subapically, the outer surfaces puberulent. Upper lateral sepal pair ca. 1.5 cm long, short-clawed, the claw ca. 3 mm long, the blade broadly ovate, apically obtuse-angled, marginally sinuate-erose, the veins converging, anastamosing, forming part of a pouch as in the spur sepal, the claw surfaces villosulous, the backs with a broad, longitudinal, yellowish-green, villous zone terminating at the subapical pouch. Lower pair of sepals about as long, slightly shorter-clawed, the blades unequilaterally ovate (the broader side upward), margined and veined as in the upper pair and with similar indumentum. Spur petals fused into 1, fully 2.5 cm long, thus prominently exserted beyond the spur sepal, the spur tube intact from spur tip to petal attachment, producing at its orifice and opposite the blade base an erect, broadly rounded ligule 3 mm high, this joined nearly its length with the petal blade auricles; petal blade ovate, of two prominent, spreading rounded auricles, the blade base nearly 1.5 cm across the auricles, and tipped by a short obovate to suborbicular, terminal lobe, this broadly bilobate apically, the inner surfaces along the auricle bases sessile-glandular within, the blade colored as in the sepals, the spur yellowish-white or greenish. Claw petals absent. Stamens ca. 6 mm long, the yellowish green anthers ca. 1 mm long, broadly ellipsoidal, the filaments broadly flattened proximally, abruptly narrowing above the middle, with a scattering of fine hairs. Carpel solitary, ca. 8 mm long, lance-ovoid, the body appressed-tomentulose, the style short, 1 mm long or less, the stigma broad, fleshy, oblique. Follicle lance-ovoid, including the short-excurved style and stigma fully 2 cm long, appressed incurved-puberulent. Seed wedge-shaped, truncate, 2.0-2.5 mm long, brownish, 3-4-angled and ridged, the faces with transversely oriented, low, wavy-margined scales.

This European species has escaped cultivation throughout our range, and is found in a variety of disturbed soils if they be sunny and dryish. It is particularly abundant in middle Tennessee in fields and along the roads, often in association with *Centaureum cyanus* and various species of annual bromegrasses. It flowers from early May through July. Plainly, it is a member of a very different complex of *Delphinium*, with its fused spur petals, its lack of claw petals, and with its single carpel. As Professor Ewan has noted

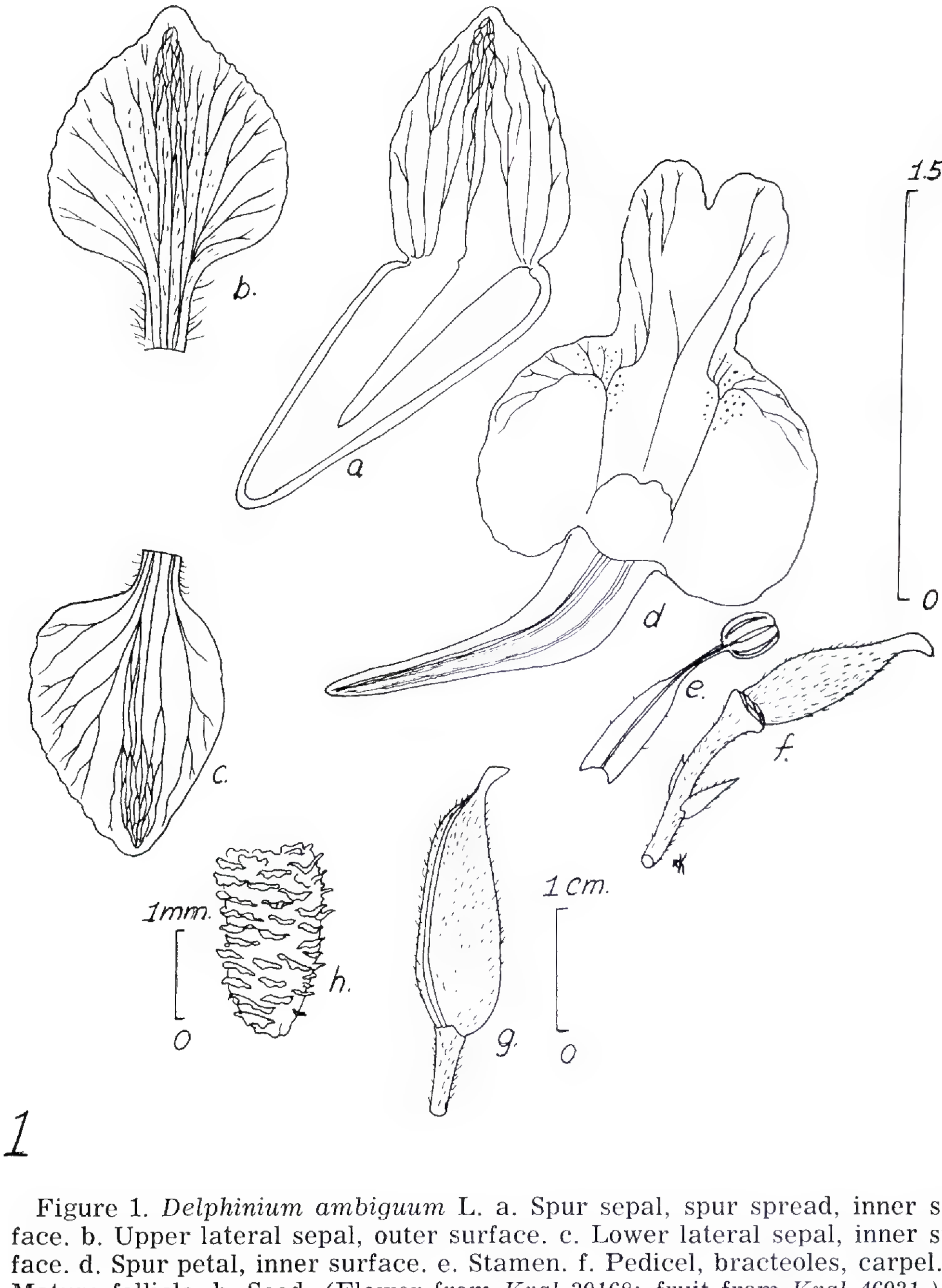


Figure 1. *Delphinium ambiguum* L. a. Spur sepal, spur spread, inner surface. b. Upper lateral sepal, outer surface. c. Lower lateral sepal, inner surface. d. Spur petal, inner surface. e. Stamen. f. Pedicel, bracteoles, carpel. g. Mature follicle. h. Seed. (Flower from *Kral 39168*; fruit from *Kral 46931.)*

(l.c.) its young stems, with the closely set, finely dissected lower leaves are very reminiscent of some Umbelliferae (e.g. *Daucus*).

2. DELPHINIUM **alabamicum** Kral, sp. nov. Fig. 2.

Herba perennis, caudici brevi tenui descendente radicibus fasciculis fusiforme brevis. Caulis 5-10 (-15) dm longis, teres, inferne rubrotinctis glabris aut retrorse pilosis, superne retrorse effuseque pilosis. Folia multis, infima sub anthesi marcescentes aut persistentes, petiolis elongatis, laminis semicircularis vel orbicularis v. suborbicularis, 5-10 cm latis, palmatisectis, segmentis primis 3-5, pleurumque 3-6 cm longis, linearis vel oblongo-linearis basi anguste cuneatis subtis sparsis piloso-hirsutis. Racemi patentes, pedicellis inferioribus arcuatisve atque bracteatis, saepe confertis antrorse tomentulis etiam pilosis. Sepalis oblongo-ovatis, 2.5-3.0 cm latis, profunde cyaneo-ionanthis, acutis vel brevi acuminatis; calcar longissima ca. 3 cm longis. Unguis petalis laminis ovatis profunde fissis longo-ciliatis. Folliculis oblongis 1.5 cm longis, apice patulis. Semina cuneata truncata subtriquetra 2 mm longa; testa nigrescentia minute pubescentibus.

Perennial from a fascicled set of fusiform-tuberous roots, to which is jointed a short, many-noded, narrow-tapering caudex. Stems mostly 5-10 (-15) cm long, usually solitary, erect, terete, at anthesis with basal nodes and internodes brownish, close-set, often leafless, then above with internodes rather abruptly elongating, the surfaces below often reddish-tinted, glabrous or pilosulous with hairs retrorsely curved; internodes of mid and upper stem longest, much longer than subtending leaves, pale yellow-green, sparsely to copiously recurved-puberulent or pilose, with an admixture of longer, spreading trichomes; peduncle and inflorescence axis mostly densely recurved-puberulent, also spreading-pilose. Rosette leaves (these often absent by anthesis) and lower stem leaves palmatisect, the segments flabellately spreading into a semicircular or orbicular outline, on slender, pilose to nearly smooth petioles much longer than the blades; primary segments 3-5, mostly 3-6 cm long, joined only at very base, linear or oblong-linear, cuneate-based, bifidly or trifidly branching into short to elongate-linear, spreading-ascending ultimate segments, these mostly acute, nipple-mucronate, the callus whitish, apically depressed; leaf surfaces yellowish-green, the upper smoothish, the lower with scattered pilosity and puberulence, this also along the margins. Leaves above mid-stem increasingly reduced, becoming sessile, mostly 3-lobed, the uppermost sessile, linear. Flowers either in a single terminal raceme or in an open, few-branched paniculate system, the total inflorescence often fully ½ the total plant length and of 15 or more flowers. Pedicels spreading, arcuately ascending, slender, the lowest longest, often several cm in length, all by anthesis longer than the flower they subtend, mostly subtended by a single, linear, acute villosulous and hirsute bract and each with 2 or 3 short-linear, similarly hairy bracteoles distally; pedicel surfaces both densely incurved-tomentulose and spreading-hirsute. Sepals an intense, deep, blue-violet, 2.5-3.0 cm broad and from tip of longest segment to tip of spur fully 3.0 cm long. Spur sepal 3 cm long, the spur 1 cm long, the blade broadly oblong, apically acute or short-acuminate, the

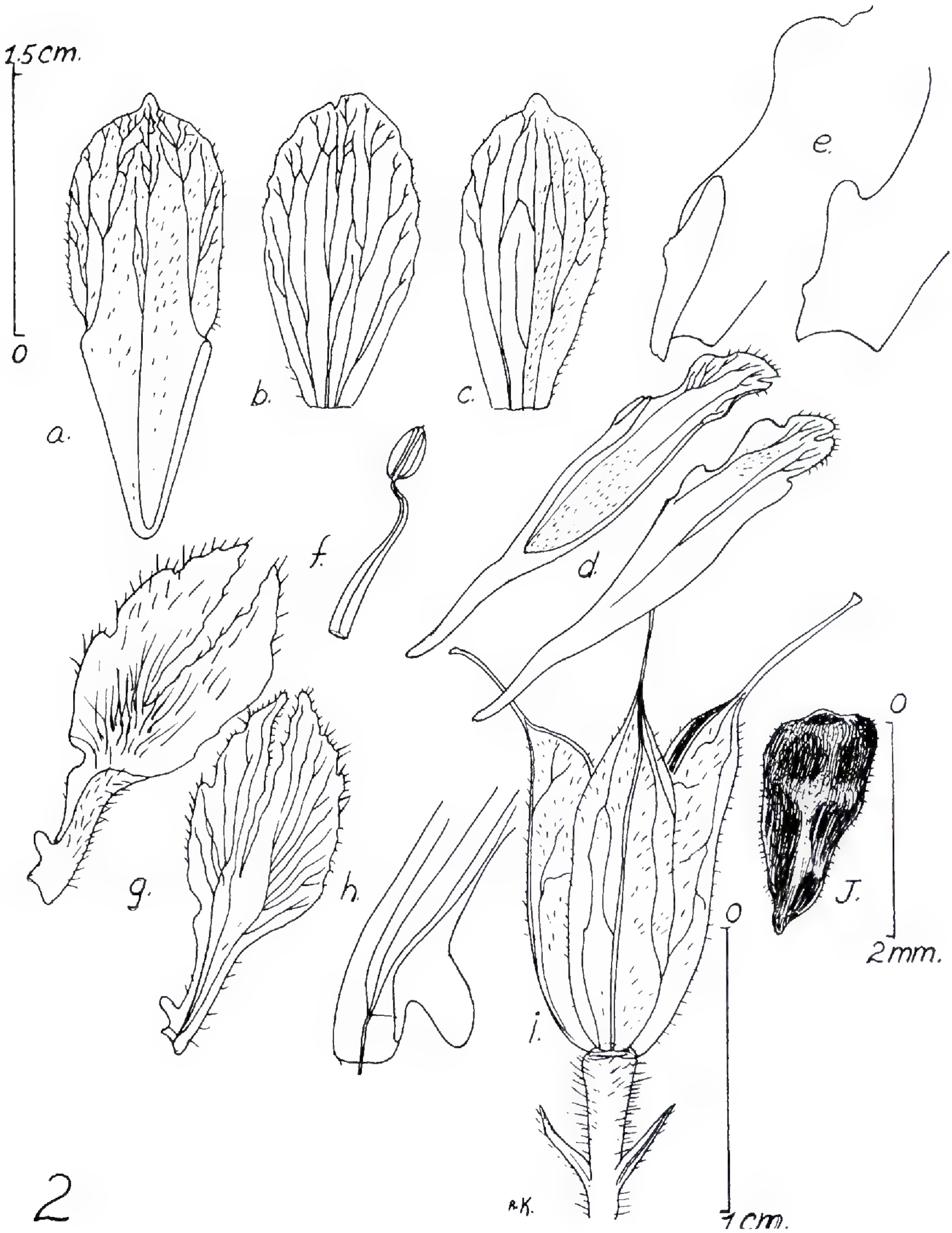


Figure 2. *Delphinium alabamicum* Kral. a. Spur sepal, spur spread, foreshortened. b. Upper lateral sepal, inner surface. c. Lower lateral sepal, outer surface. d. Spur petals. e. Spur petal blade base, much enlarged inner and outer views. f. Stamen. g. Claw petal. h. Base of claw petal. i. Pedicel and mature fruit. j. Seed. (Flower and fruit drawn from holotype, *Kral 39113*.)

margin spreading-ciliolate, the inner surface smoothish, the outer surface spreading-pilose. Lateral sepal pairs subequal, mostly oblong or obovate, ca. 1.5-1.7 cm long, acute to obtuse, broadly cuneate-based, the outer surfaces (backs) strongly strigose or hirtellous, particularly in the median-longitudinal zone. Spur petals ca. 3 cm long, the closed part of the spur ca. 1 cm long, the blade pale blue to near white, ovate, apically acutish, with a narrow, subapical cleft, the margins ciliate, the backs pilosulous or pilose; inner surface of spur minutely puberulent, that of blade sometimes with scattered pilosity along larger veins. Claw petals bluish, ca. 1.5 cm long, the claw ca. 0.5 cm, bearing at its upper margin basally a spreading, short-oblong, erect auricle, the blade elliptical or ovate, ciliate-erose, cleft narrowly from the roundish or acute apex nearly to the attenuate base, the backs villous, the inner surfaces pilosulous. Stamens ca. 1 cm long, the filaments flattened proximally, gradually narrowing and thickening toward the connective, smooth or sparsely hirsute; anthers ellipsoidal, usually smooth. Carpels narrowly lance-ovoid, ca. 0.5 cm long, the ovary sericeous. Mature follicle bodies oblong, ca. 1.5 cm long, slightly spreading apically, the styles ca. 0.5 cm long, slender, persistent, arching outward. Seeds somewhat asymmetrically obconic, obtuse-angled, truncate, 2 mm long, minutely soft-spreading-hairy, nearly black.

Heavy soil of calcareous clearings in cedar barrens, blackland prairies, black belt Alabama (where perhaps now exterminated) and in the Highland Rim of northwestern Alabama. Flowering from May to mid-June.

Type. ALABAMA. Franklin Co.: limestone glade ca. 5 mi. s. of Russellville by US 43-Alabama 17, 26 May 1970. *R. Kral 39113*. Holotype US. Isotypes to be distributed.

My observations of this species so far are confined to populations scattered in Franklin County Alabama where it is locally abundant in open limestone glades, there in association with such plants as *Petalostemon gattingeri, Arenaria patula, Leavenworthia* spp., *Psoralea subacaulis, Onosmodium molle, Schoenolirion croceum*, etc. Usually it is on heavy clay and in full sun, though scattered individuals may be found amongst invading *Juniperus virginiana* and other early woody successional stages. Examination of specimens in the U.S. National Museum has shown specimens of C. Mohr identified as *D. exaltatum* and gotten from Uniontown (Perry County) and Cedar Plain, thus the species at least at one time was to be found in the Black Belt prairies. Mohr cited it under *D. urceolatum* Jacq.,[(this, according to Ewan (l.c.) based on a garden grown plant of unknown origin, possibly however of the European *D. elatum*)] used *D. exaltatum* as a synonym, and indicated (1901) that this plant was found in Lawrence County (Moulton) and Dallas County (Marion Junction). From his description of the color of the flowers and the habitat, as well as from those specimens of his I have seen, there is little doubt that the plant Mohr referred to is the same as this "new" species. However, my own attempts to find *D. alabamicum* at any of these

Black Belt localities have thus far been futile. These open lands have been so suitable for row crop agriculture or improved pasture that it has possibly been wiped out in that part of its range.

D. alabamicum appears as an interesting combination of the characteristics of *D. tricorne* and *D. carolinianum*. It has the short, weak, tapering caudex and tuberiform rootstock, together with the larger, more spreading-pedicelled flowers of the former and, like it, has the subapical sepal "pouch" poorly if at all developed. On the other hand its taller habit, its pilosity of stems and petals, and its narrower leaf segments are toward *D. carolinianum*. Further, its mature follicles ascend more than is the case in *D. tricorne*, less than in *D. carolinianum*. The seed, while similar in general character to that of *D. tricorne*, is black.

Plants moved to my garden in Nashville have bloomed true to character for two years and, because of their stature, large, numerous, showy flowers, and relatively long period of bloom, make a very handsome sight.

3. DELPHINIUM TRICORNE Michx., Fl. Bor. Am. 1: 314. 1803.

Delphiniastrum tricorne (Michx.) Nieuwl., Am. Midl. Nat. 3: 172. 1914.

Stems usually solitary from a small cluster of fusiform-tuberous roots, erect, 1-4 (-6) cm tall, stiffish but soft, hollow, the lower part with short, zig-zag, narrow internodes (the caudex) tapering into the fascicled tubers; internodes abruptly broader above the caudex, elongating and longest toward mid-stem, then tapering gradually upward on a (usually) long primary peduncle; stem surfaces brownish or maroon-tinted proximally, becoming greenish-stramineous, even reddish-tinted upward, smooth or sparingly decurved-pilose proximally but often with a heavier, incurved pilosity in the inflorescence. Leaves few, tending to be concentrated toward the stem base, the lowest scale-like on the first 1-2 nodes, those just above largest, spreading or ascending on pilose petioles several times longer than the blades, the blades mostly orbicular to reniform in outline, deeply palmatisect, the primary segments mostly (3-) 5 (-7), in outline mostly oblanceolate or cuneate, themselves dissected into narrow fans, the sinuses narrow, the ultimate lobes mostly oblong to short-oblong, narrowly triangular or ovate, acute to nipple-tipped; leaf surfaces pale green, the upper darker, smoothish to appressed-puberulent or scattered-pilose, the lower strongly to weakly pilose, hairs longest and most abundant along the veins. Leaves becoming abruptly smaller and sessile just below the primary peduncle, the inflorescence bracts commonly unlobed or few lobed, the uppermost ones short-linear. Inflorescence a simple raceme or a compound of a few racemes, the flowers few and distant or many and somewhat crowded, cylindric, or narrowly conic, the spreading-ascending slender pedicels longest toward the raceme base, pilose to tomentulose, mostly subtended by a short-linear or lanceolate, pilosulous bract and producing a pair of subopposite, linear-lanceolate bracteoles ca. 3 mm long just below the torus. Sepals from deep

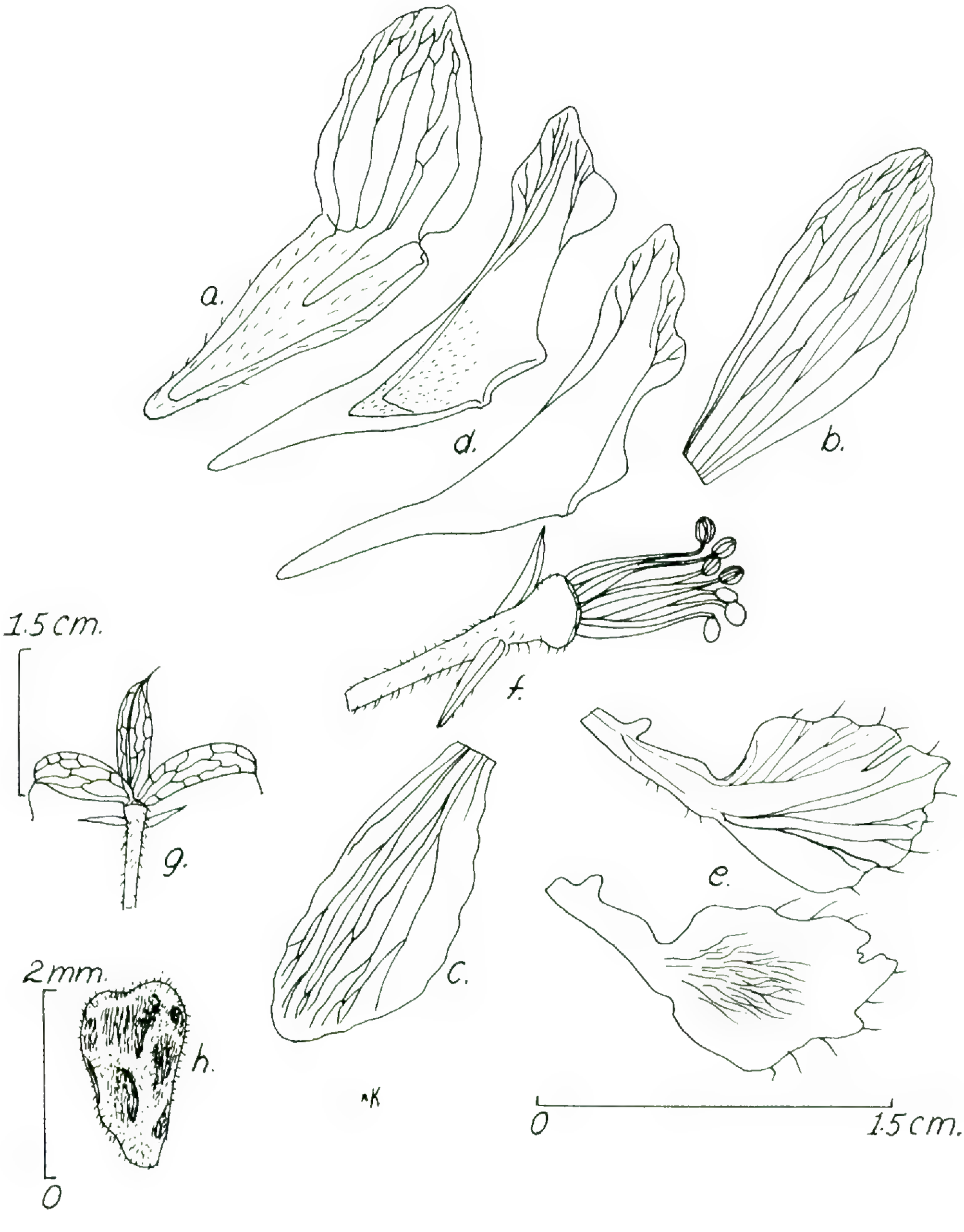


Figure 3. *Delphinium tricorne* Michx. a. Spur sepal, spur spread, outer surface. b, c. lateral sepals. d. Spur petals. e. Claw petals. f. Pedicel, receptacle, stamens. g. Ripe fruit. h. Seed. (Flower parts from *Kral 45638*; fruit and seed from *Quarterman et al. 4904*.)

blue-violet through pale blue to near white with lavender splotches subapically on sepal tips. Spur sepal 2.0-3.0 cm long, the narrowly conic spur ca. 1.5 cm long the somewhat spreading blade broadly oblong, obtuse, slightly crispate to subentire, ciliolate, the outer surface scattered-pilose. Lateral sepal pairs subequal, somewhat asymmetrically elliptic-oblong, 1.5-1.8 cm long, rounded, ciliolate and wavy-margined, externally scattered pilose in a broad median-longitudinal zone. All sepal blades with main veins arcuately converging and anastomosing subapically, there forming a somewhat thicker, sometimes slightly pouched zone. Spur petals ca 2 cm long, the petal attachment ca. 1.5 cm from the spur tip, the spur closed for 8-9 mm from the tip; petal limb irregularly oblong, terminally asymmetrically ovate, the margin sinuous-crispate, the apex bluntly acute, the surfaces smooth above save for puberulence within the spur, sparsely villosulous externally. Claw petals usually deeper colored than the spur petals, but paler than the sepals, ca. 1.5 cm long, the claw 5-6 mm long, the blade broadly ovate to suborbicular, the margin strongly sinuate to erose, the apex rounded with a strong narrow, shallow to deep cleft subapically; upper surface of blade strongly pale-villous at least proximally and medially, there marked also by a yellowish-white medial patch. Filaments about 7 mm long, smooth or sparsely ciliate; anthers asymmetrically suborbicular, ca. 1 mm long. Carpels lance-ovoid, smooth or with scattered weak appressed hairs on the ovaries. Mature follicles, including the persistent style, narrowly oblong, laterally somewhat compressed, ca. 1.5 cm long, strongly outwardly curvate, nearly smooth or scattered-pilose. Seeds dark brown, irregularly wedge-shaped, truncate, ca. 2 mm long, minutely spreading-puberulent.

Rich, moist, mostly circumneutral or slightly basic loamy soils of deciduous woodlands from Pa. south into Ga., westward into Minn. and Okla. In our area this is the common woodland *Delphinium* from northern Alabama through most of Tennessee. Here it flowers from late March to early June.

In richest sites the fistulous stems become quite stocky and tall, but in large populations on average sites most plants do not exceed 3 dm. By the time the fruits appear the plants are already beginning to die back, usually completely so by July. In the calcareous woodlands of northern Alabama and middle Tennessee there are many populations that are prevalently white or yellowish-white with tints of lavender or blue-violet, or this confined mainly to the spur sepal. These same show deeper splotches of color in the subapical, anastomosed, sepal zone of the sepals.

In open woods which have had a history of grazing and then abandonment, this species is one of the first herbaceous elements to return. The plants are definitely toxic to livestock and probably sustain damage only through alteration of the soil through trampling by stock.

4. DELPHINIUM EXALTATUM Ait., Hort. Kewensis, ed. 1. 2:244. 1789.
D. tridactylum Michx., Fl. Bor. Am. I: 314. 1803.
Delphinastrum exaltatum (Ait.) Nieuwl., Am. Midl. Nat. 3:172. 1914.

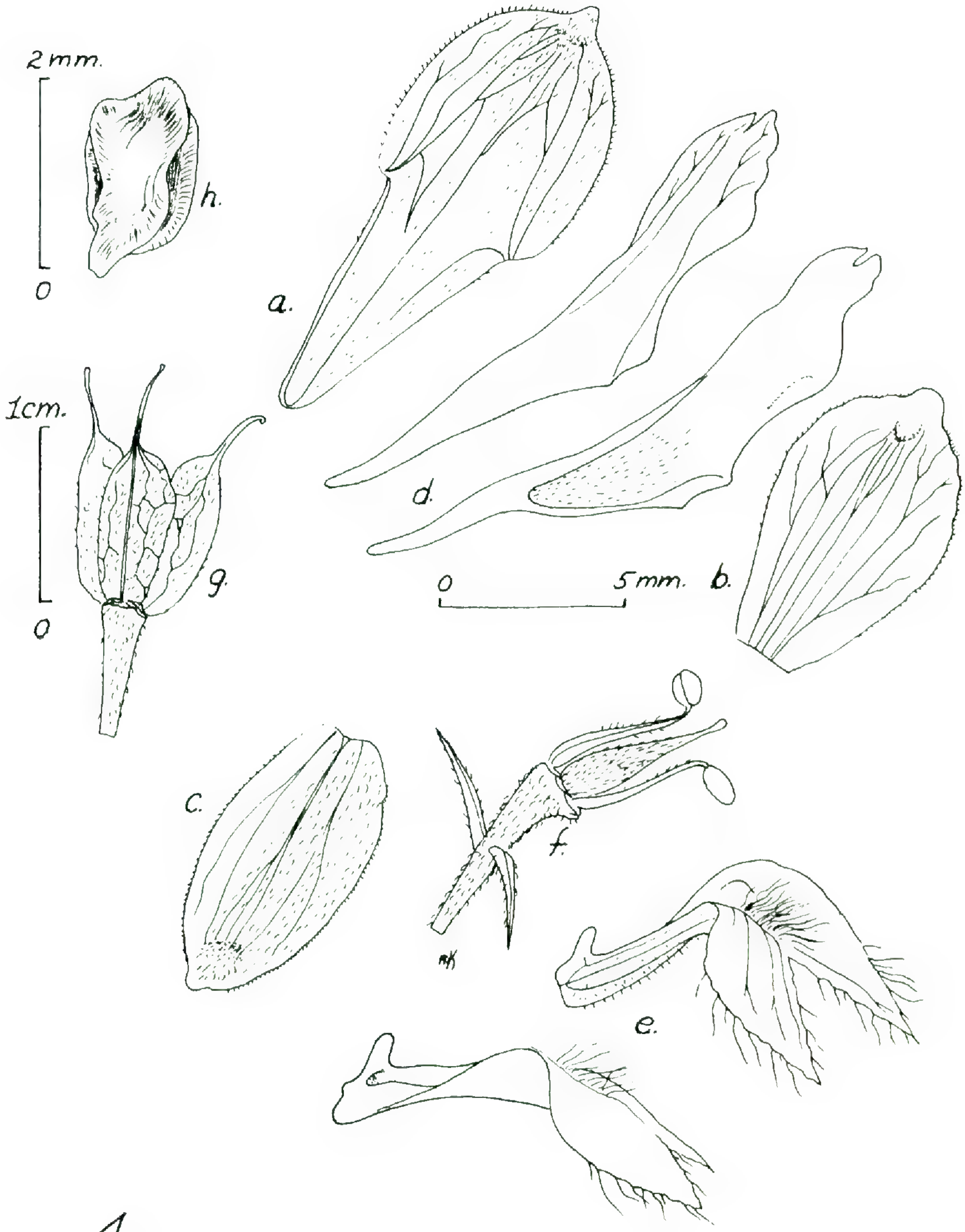


Figure 4. *Delphinium exaltatum* Ait. a. Spur sepal, spur spread, outer surface. b. Upper lateral sepal, inner surface. c. Lower lateral sepal, outer surface. d. Spur petal pair, lower showing inner surface. e. Claw petal pair. f. Pedicel, bracteoles, receptacle, stamens, and a carpel. g. Ripe follicles. h. Ripe seed. Drawn from *Kral 11137* (Montgomery Co., Virginia).

Stems usually solitary from a thickened, woody, taprooted (or branched-taprooted) caudex, erect, 1.0-1.5 m tall, terete to somewhat sulcate, slender but firm, the lowest internodes shortest, usually purplish tinted, smooth, gradually lengthening toward mid-stem, longer than the shortening petioles and blades; stem surfaces above base greenish or stramineous, smooth to the level of the inflorescence, there increasingly crisped-incurved-puberulent toward the apex. Lowest leaves gone by anthesis, the lowest green ones on terete, slender, glabrous to sparingly hirsute petioles longer than the blades, the blades in outline suborbicular to semi-circular, usually truncate-based, deeply and palmately divided into 3 (-5) oblanceolate to elliptic-linear or lanceolate primary segments, the sinuses narrowly acute to narrowly rounded, the segment bases broadly to narrowly cuneate, the secondary segments from 1- several, the lowest oblong-linear, salient to ascending, the shorter narrowly triangular, all segment tips narrowly acute to acuminate, somewhat thickened but still flattish, lacking mucrones; leaf surfaces deep green above, paler beneath, sparingly incurved pubescent along the margins and the several parallel veins above, more generally appressed pubescent beneath. Leavs grading gradually upward into the inflorescence, this usually a compound of slender, elongate racemes of numerous flowers, the basal well separated, the ones at anthesis or in bud approximate, the pedicels slender, ascending at an angle of about 45° or less, crisped-tomentulose, each subtended by a linear, acuminate, incurved-puberulent bract together with a distal pair of short-linear or oblong, puberulent or tomentulose bracteoles. Sepals pale dull blue or blue-violet, this lined with yellow-orange or yellow-white. Spur sepal ca 2 cm long, the spur 1 cm long, the blade broadly ovate, short-acuminate or mucronate apically, with a subapical shallow pocket, marginally ciliolate, the back crisped-puberulent. Other sepals broadly oblong to obovate, ca. 9 mm long, the upper pair somewhat broader, apically rounded or with a low mucrone, each with a subapical pouch, the margins erose and ciliolate, the backs medially puberulous in a broad zone, the inner (upper) surfaces smooth. Spur petals slightly longer than the spur sepal, the closed (tubular) part of the spur ca. 5 mm long, the attachment point ca. 10 mm from the spur tip, the limb with the lower edge bearing a long shallow sinus between 2 thickened low lobes, the limb apex asymmetrically ovate, blue, sparingly trichomiferous apically bifid into 2 unequal, narrowly triangular lobes. Claw petals 1.0-1.2 cm long, blue, the claw ca. 5 mm long, bearing just above its short-compressed-tubular base an upward projecting spur ca. 0.5 mm long; blade broadly, asymmetrically ovate, strongly bent downward, bearing a pair of longitudinally oriented, low calluses on either side of the mid-nerve at the claw junction, deeply split by a narrowly acute sinus, the lobes unequal, narrowly acute, the margins erose and long-ciliate; upper (inner) surface of blade strongly villous medially; lower (outer) surface of claw puberulous, of blade sparingly villous. Stamens ca. 5 mm long, the anthers ca. 1 mm long, ellipsoidal, the locules

sparingly short hairy, the filament margins sparsely ciliate. Carpels ca. 5 mm long, the ovaries ca. 2.5 mm long, narrowly lance-ovoid, sericeous. Mature follicles erect, diverging only apically, short-oblong, ca. 9 mm long, incurved-puberulent, the persistent glabrous style ca. 2 mm long, excurved. Seeds asymmetrically cuneate, truncate, alately 3-angled, 2.0-2.2 mm long, buff or pale brown.

Rich, moist loamy soils of open calcareous wooded ravines, mainly in the mountains, Penn. and Ohio south into N.C., Tenn. and Ky. (Mississippi?).

This, with the possible exception of *D. alabamicum* is the rarest of the Delphiniums of the southeastern United States. My own field experience with it has been limited to the mountains of southwestern Virginia where it is of sporadic occurrence in mixed-mesophytic forested ravines that cut into shales and limestones. It has a deep, heavy root system in comparison with our other species, and the smallish flowers are less attractive, being of a dull shade of blue. It tends also to be more branched, the main axis putting forth several upwardly arching lateral shoots. While the other species tend often to be locally abundant, sometimes forming stands, this is usually scattered with but few plants in any locality.

5. DELPHINIUM CAROLINIANUM Walt., Fl. Car. 155. 1788.
Delphinium azureum Michx., Fl. Bor. Am. 1:314. 1803.
Delphinastrum carolinianum (Walt.) Nieuwl., Am. Midl. Nat. 3:172. 1914.

Stems solitary or few from a stoutish, erect caudex, this frequently tuberously branched, or a small fascicle of fusiform tubers, erect, to 1.5 meters tall, terete, slender but firm, the lowest internodes shortish, maroon or red-tinted, these gradually lengthening toward mid-stem, there much longer than subtending petioles; stem surfaces below mid-stem usually copiously puberulent with pale, downcurved hairs, above mid-stem at least in the inflorescence strumose-hirsute with yellowish (often glandular) hairs and/or crisped-pale-puberulent. Rosette leaves and lowest stem leaves absent by anthesis, the lowermost leaves long-petiolate, the blades tenuisect, in outline semicircular, the primary divisions usually 3, each linear-based and pinnatifid, the secondary segments broadly to narrowly linear, spreading or ascending, simple or themselves sparingly pinnatifid; segment apices narrowly acute, terminating in a conic pale callus; surfaces of petioles puberulent to pilose, those of segments with pale, incurved trichomes along the margins and mid-veins at least beneath. Uppermost leaves sessile or nearly so, with fewer, narrower segments. Inflorescence a single, narrow, elongate raceme or a sparse ascending-branched system of these, the numerous flowers on (usually) shortish, erect to strongly ascending, hirsutulous and/or puberulous slender, stiffish pedicels, each subtended by a short (mostly less than 1 cm), lance-linear, appressed-hairy bract and with (1-) 2-3 (-4) still shorter bracteoles, 2 usually present and subopposite near the torus. Sepals usually a bright, pale blue or blue-violet. Spur sepal 2-3 cm long, the nar-

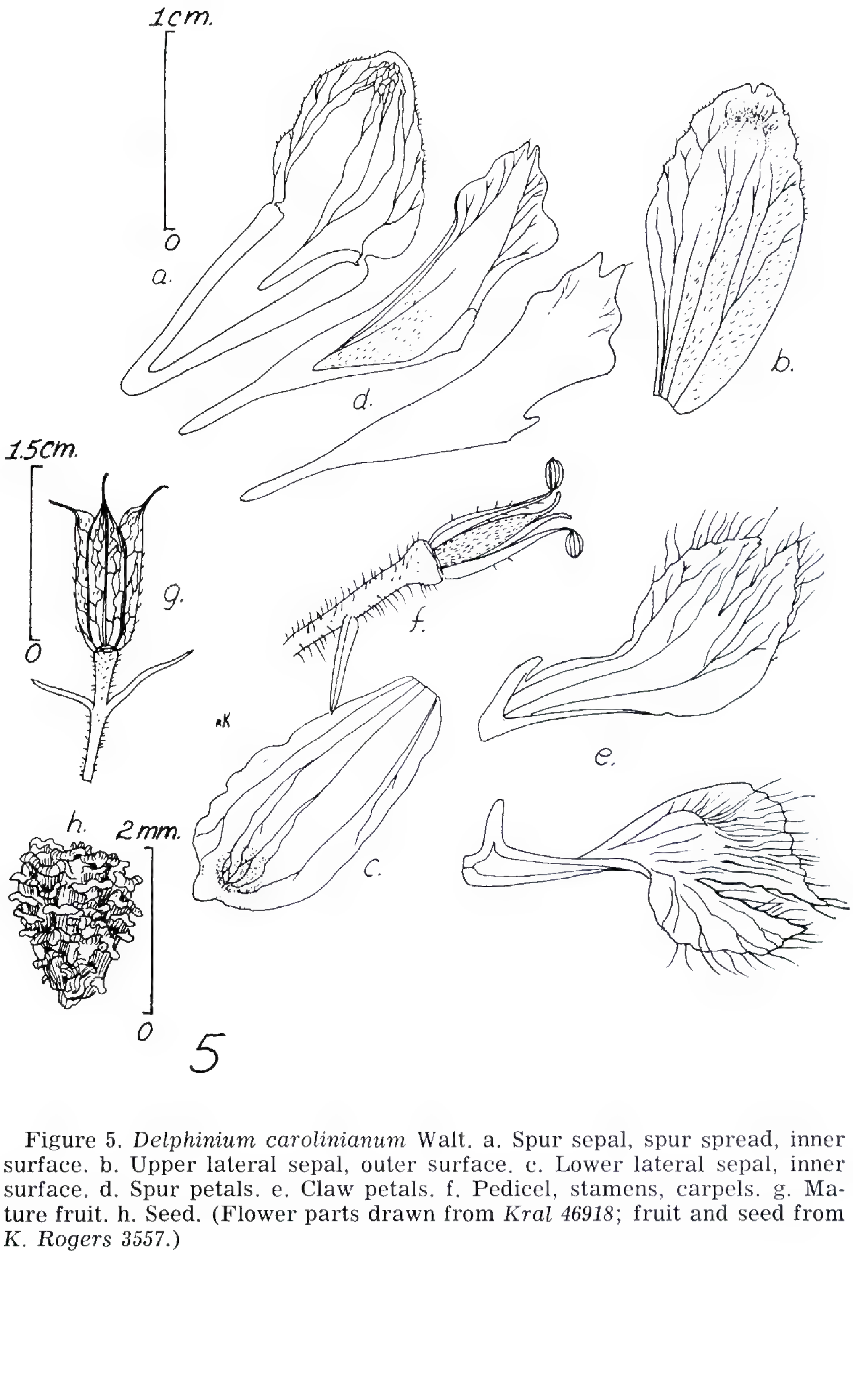


Figure 5. *Delphinium carolinianum* Walt. a. Spur sepal, spur spread, inner surface. b. Upper lateral sepal, outer surface. c. Lower lateral sepal, inner surface. d. Spur petals. e. Claw petals. f. Pedicel, stamens, carpels. g. Mature fruit. h. Seed. (Flower parts drawn from *Kral 46918*; fruit and seed from *K. Rogers 3557*.)

rowly conical spur between ½ and ⅔ the total length, the blade bent upward, ovate, apically broadly acute or obtuse and bearing a large, subapical, shallow "pouch," the margin entire, or undulate, the outer surface appressed or incurved puberulent, the inner (lower) surface smoothish. Other sepals 1.0-1.5 cm long, oblong, acute to rounded, entire to erose and ciliolate, each producing subapically a dark-colored shallow pit or pouch; sepal backs crisped or appressed puberulent, with a villous or pilosulous broad median zone, the hairs most abundant on the sepal pouch. Spur petals 2.2-2.5 cm long, the tube 7-8 mm long to the sinus, ca. 1.5 long to the attachment point, the lower edge of the blade with sinus between callused lobes ca. 5 mm long, the lobe apex ovate, acute, apically bifid, the lobe tips blue, bluntly acuminate, sometimes with a few long pale, tufted trichomes. Lower petals 1.0-1.2 cm long, the claw ca. 5 mm long, bearing at its short-tubular base an upwardly directed narrow spur 1.5-2.0 mm long and apically 2 short, longitudinally oriented calluses; blades downwardly directed, ovate, acute, long-ciliate, nearly split by a narrow, deep sinus, blue, the upper surface villous with long yellowish hairs, the backs glabrous. Stamens ca. 7 mm long, the flattish filaments sometimes with a few long hairs, mostly smooth, the anthers broadly ellipsoidal, sometimes with locule backs having a scattering of slender, but rigid short white hairs. Carpels with ovaries lance-cylindrical, appressed-tomentulose, ca. 2 mm long, the styles usually blue, ca. 1 mm long, glabrous. Follicle bodies asymmetrically oblong, erect, diverging only apically, incurved puberulent, ca. 1.0-1.5 cm long, the persistent styles ca. 3 mm long. Seed broadly wedge-shaped, 1.7-2.0 mm long, truncate, grayish, with (usually) 3 prominent longitudinal ridges and numerous, irregularly transversely oriented scale-like processes.

Moist to dryish, usually calcareous, clearings, limestone outcrops, glades, prairies, throughout black belt Alabama and locally abundant, scattered elsewhere in the state. Flowering from early May through July. The species is more abundant and widespread west of the Mississippi, ranging from Illinois and Missouri south through Arkansas into Louisiana and southwest through Oklahoma into Texas. East of the Mississippi it is local in the Carolinas, Georgia, (with one locality known for Middle Tennessee), and Mississippi. The bright pale blue flowers, borne in long spikelike racemes make it one of our handsomest natives.

6. DELPHINIUM VIRESCENS Nutt., Gen. N. Am. Pls. 2:14. 1818.

Delphinastrum virescens (Nutt.) Nieuwl., Am. Midl. Nat. 3:172. 1914.

Stems solitary or few from a thickish, erect caudex, this branching at its base into thickish roots or a fascicle of fusiform tuberous roots, erect, 2-10 dm tall, terete, slender but firm, the lowest internodes shortest, greenish or tan, rarely with some maroon tints, smooth, gradually lengthening toward mid-stem, there longer than the shortening petioles and blades; stem surfaces (in ours) usually smooth up to mid-stem, from there upward becoming

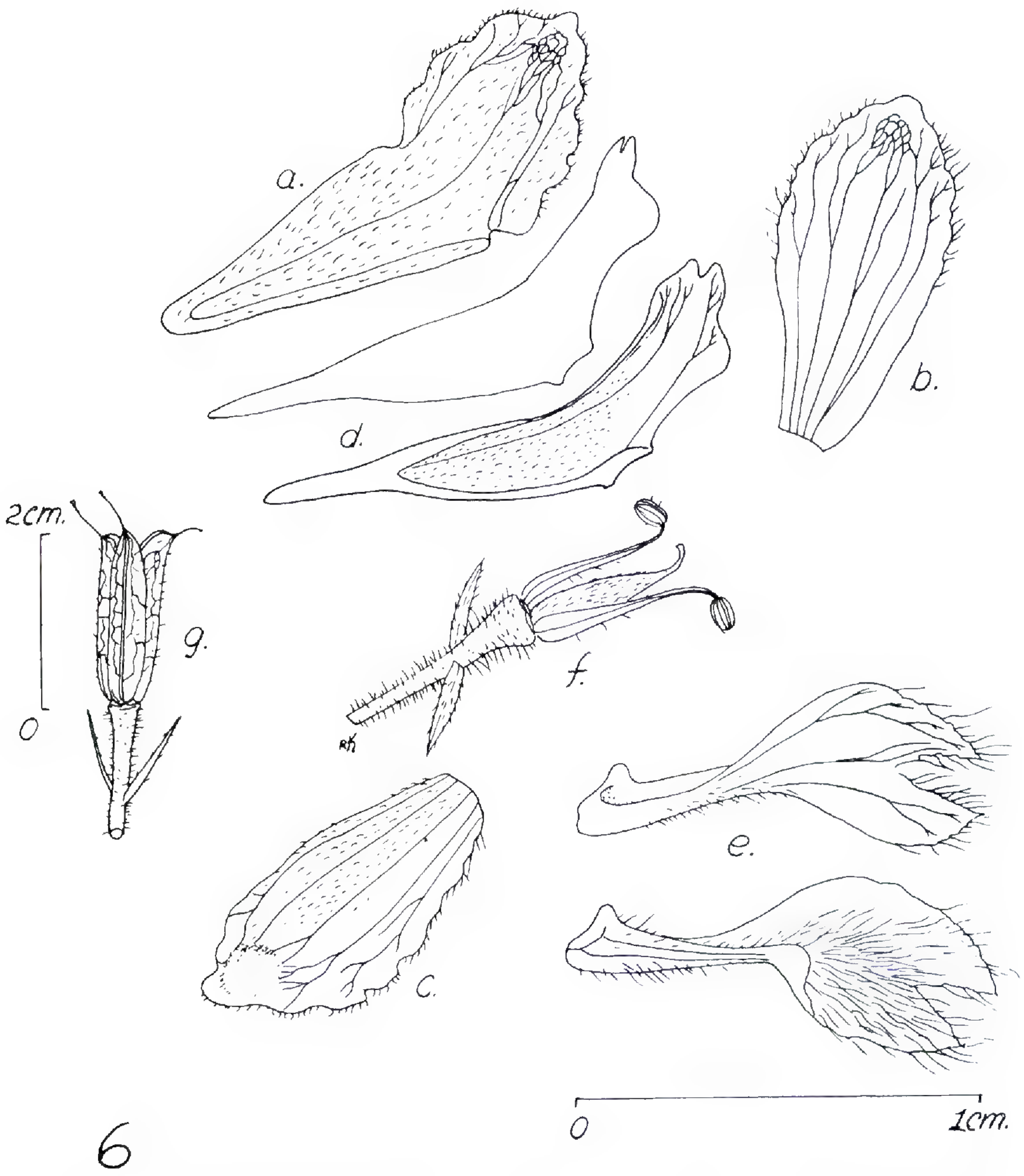


Figure 6. *Delphinium virescens* Nutt. a. Spur sepal, spur spread, outer surface. b. Lower lateral sepal, inner surface. c. Upper lateral sepal, outer surface. d. Spur petals. e. Claw petals, the lower showing upper (inner) surface of blade. f. Pedicel, receptacle, stamens, carpel. g. Mature fruit. (Flower and fruit from *Blum 3615*.)

increasingly pilose with whitish or yellowish trichomes, the longer ones pustular-based and frequently gland-based, these in the inflorescence intermingled with shorter, incurved hairs. Lowest leaves usually dying back by anthesis, the lower green ones with ascending, smoothish (or scattered-pubescent) petioles longer than the tenuisected blades, these in outline semicircular to suborbicular, the primary divisions usually 3, each linear-based

and pinnatifid, the secondary segments broadly to narrowly linear, these simple or themselves distantly pinnatifid; segment apices long-to-short-acuminate, each mucro-tipped with a low callus; segment surface nearly smooth, with incurved trichomes along the margins and primary veins, pale green. Inflorescence a single, narrowly-elongate raceme or a sparingly, ascending-branched system of these, the flowers numerous on shortish, erect to strongly ascending, hispidulous-hirsute, slender pedicels, each subtended by a linear, pilose bract, and bearing distally a pair of short-linear pubescent bracteoles. Sepals usually yellowish-white, tinted with a suggestion of blue, lavender or violet or sometimes a dull near-blue. Spur sepal 1.5-2.2 cm long, the narrowly conic spur ca. ⅔ the total length, the blade bent upward, ovate, the tip rounded-squarrose, the margin sinuate-crispate, the outer surface incurved puberulent, denser and villosulous in the area of the deeper-colored subapical pouch, the inner surfaces largely smooth. Other sepals oblong or narrowly obovate, slightly asymmetrical, 1.0-1.2 cm long, the apices narrowly rounded, the margins sinuate-erose, long-ciliate, the outer surface puberulent, strongly so in the area of a large shallowly-saccate subapical pit, the inner surfaces essentially smooth. Spur petals about the length of the spur sepal, off-white, the closed portion of the spur narrow, ca. 5-7 mm long, thence expanding to the attachment point ca. 1.5 cm from the spur tip; lower edge of the blade with a broad, shallow sinus between callused lobes, the blade apex ovate, bifid, thus tipped with 2, narrowly triangular teeth, the surfaces smooth save for minute puberulence within the spur. Lower petals ca. 1 cm long, the claw ca. 5 mm long, bearing at its short tubular base an upwardly directed low spur ca. 1 mm long; blades downwardly bent, ovate, acute, long-ciliate, nearly split by a deep, narrowly triangular, acute sinus, yellowish-white, the upper surface villous with long, yellowish-white hairs, the backs essentially glabrous. Stamens ca. 7 mm long, the anthers ca. 1 mm long, the anther locule backs and the filament margins often with a scattering of weak hairs. Carpels with ovaries lance-cylindrical, acuminate, tomentulose, ca. 2 mm long, the styles yellowish, ca. 1 mm long, smooth. Follicle bodies asymmetrically oblong, erect, spreading only apically, 1.5-2.2 cm long, the persistent styles ca. 3 mm long, the surfaces puberulent and veiny. Seeds similar in size and sculpture to *D. carolinianum*.

D. virescens is a species of heavy, calcareous soils of cedar barrens, prairies, and rocky clearings through most of middle Tennessee and from one disjunct locality in northern Alabama. It flowers from April through most of June. Our examples all fit Professor Ewan's description (1945) of the variety *virescens* which has a distribution, in prairies, from southern Canada southward into north-central Texas. East of the Mississippi it is rare in Illinois and Kentucky, but quite abundant in several counties of Tennessee.

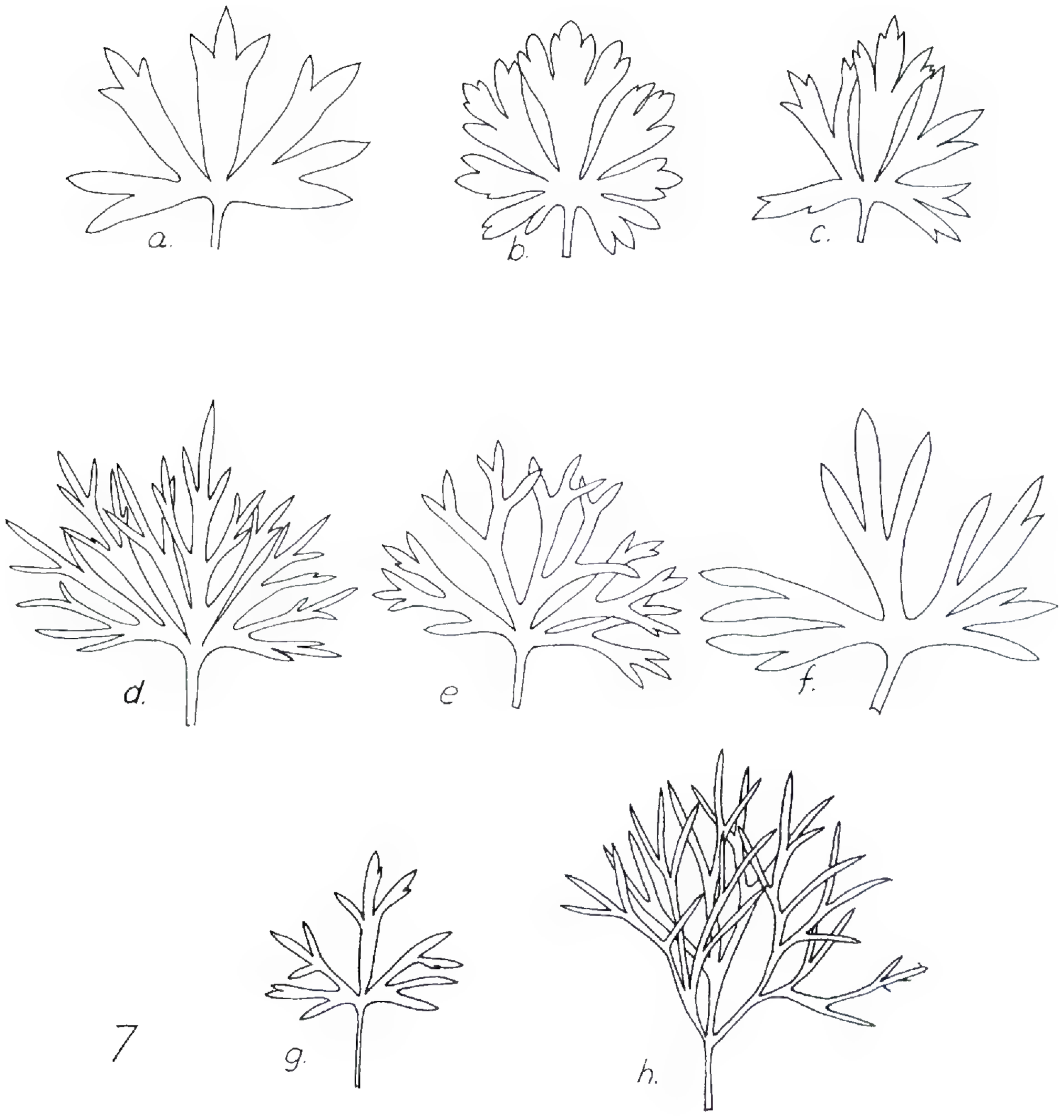
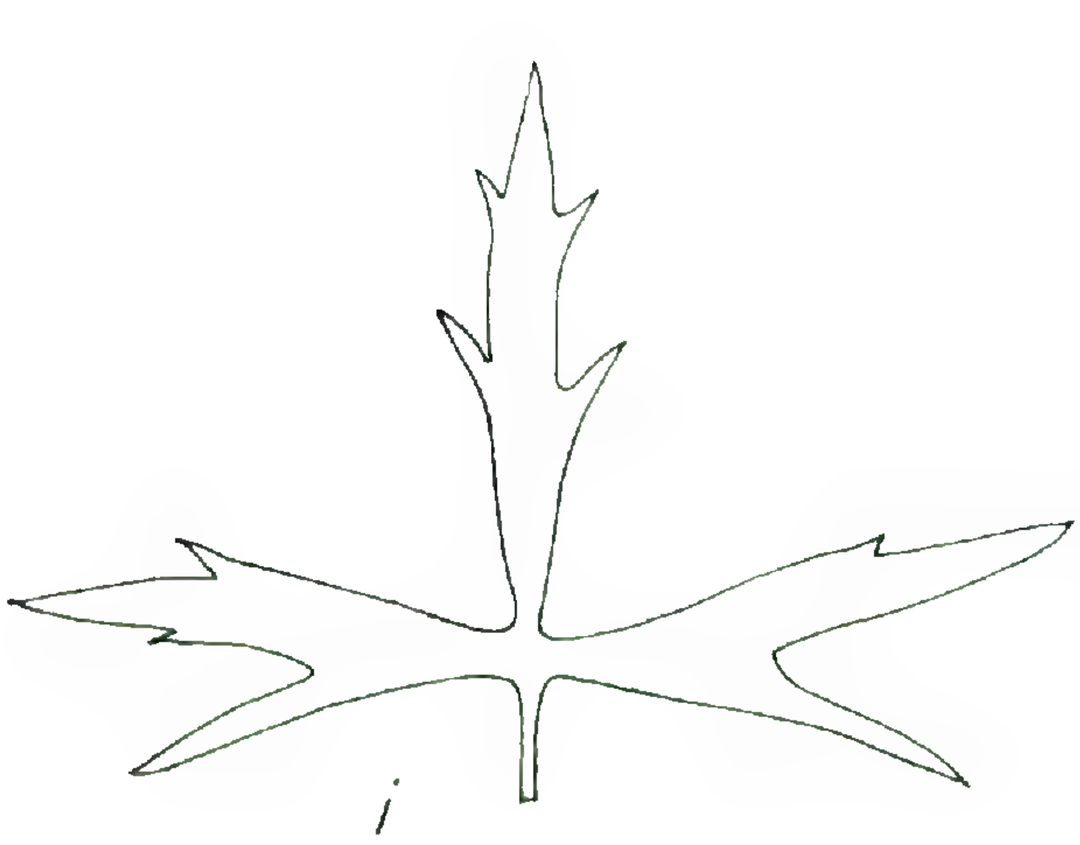
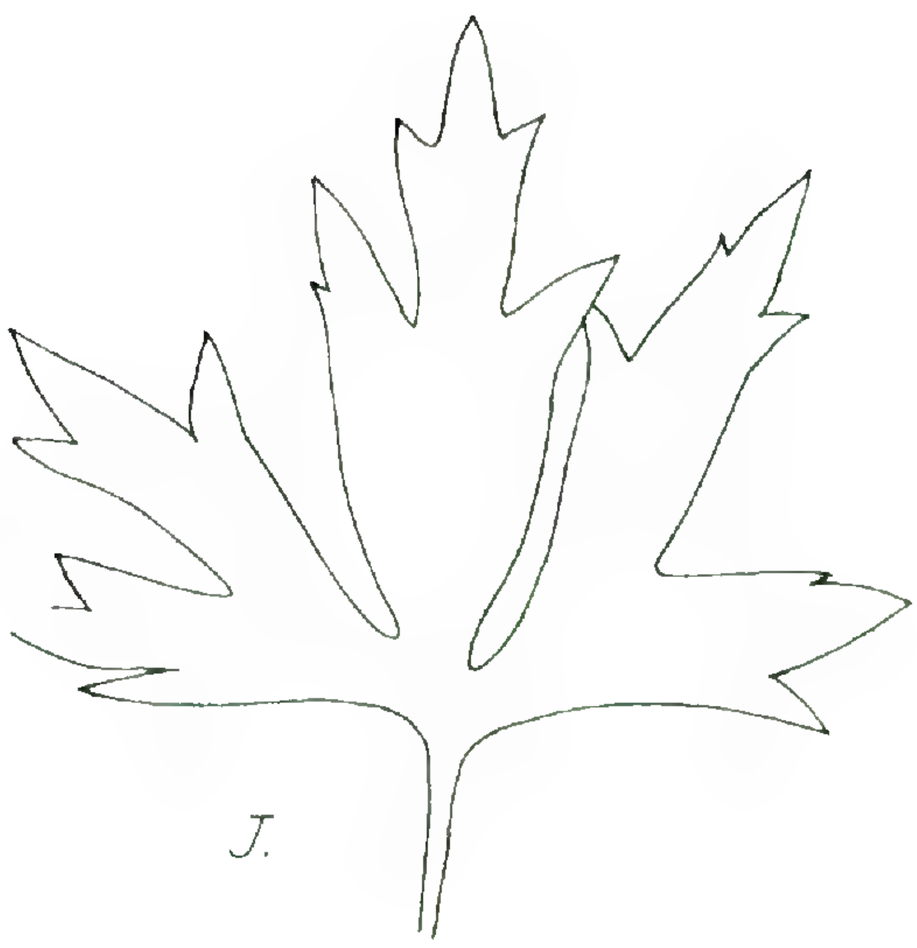
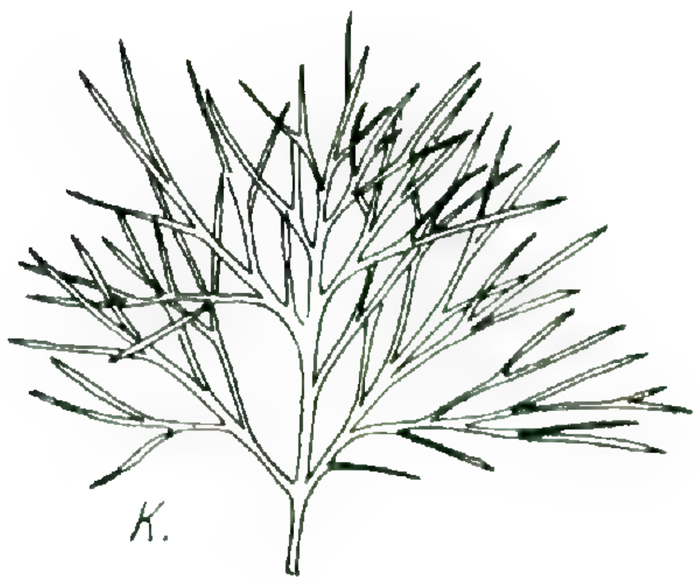


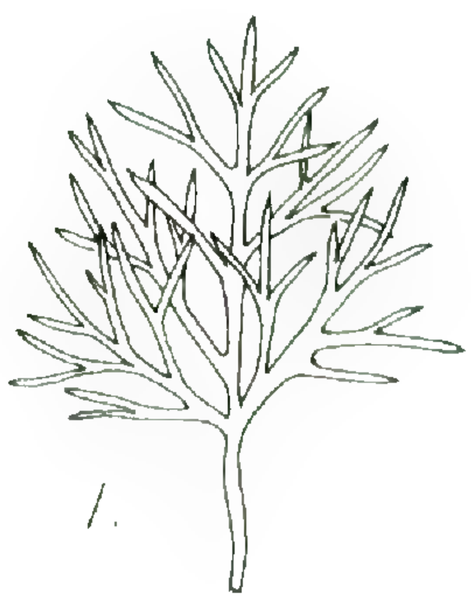
Figure 7. Some outlines representing basal leaf blades of *Delphinium* species. *D. tricorne* Michx.: a. *Angel 30*; b. *F. wolf*, 26 Apr. 1940; *c. Bernard 24. D. alabamicum* Kral: d., e., f. *Kral 39113* (holotype). *D. carolinianum* Walt.: g. *Thomas 18669*; h. *Kral 44019*.

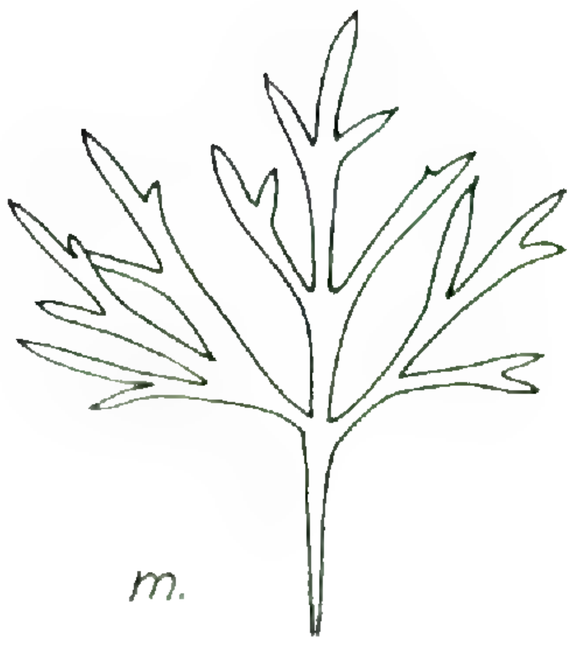
There is no doubt that it is taxonomically very close to *D. carolinianum*, which it closely resembles in habit, leaf, pubescence, sepal and petal characters (including the saccate perianth tips), stamens, and seed. Indeed, pigment characters and minor corolla characters distinguish it at best. In Missouri, where populations of the two species appear to overlap, it would be of interest to note if intermediates occur.











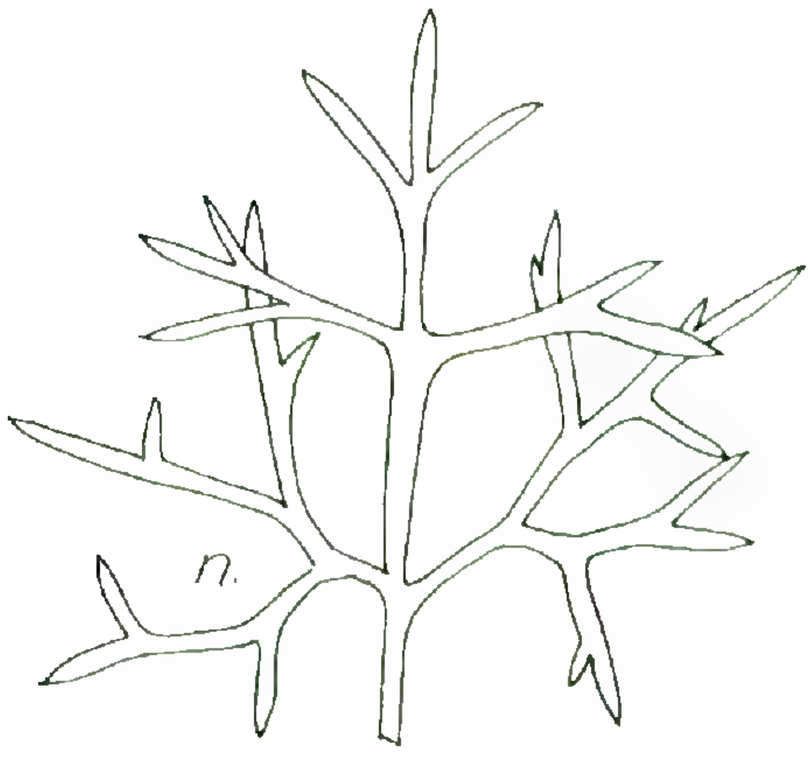


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Figure 8. Some outlines representing basal leaf blades of *Delphinium* species. *D. exaltatum* Ait.: i. *Bozeman 10701*; j *Kral 11137. D. ambiguum* L.: k,. l. *Kral 28509. D virescens* Nutt.: m., n. *Kral 39163.*

REFERENCES

EWAN, JOSEPH. 1945. A synopsis of the North American Species of *Delphinium*. Univ. Colo. Studies 2, No. 2: 55-244.

FERNALD, M. L. 1950. Gray's Manual of Botany, ed. 8. American Book Company.

HEYWOOD, V. H. and P. W. BALL. 1962. Taxonomic and nomenclatural changes in the Spanish Flora. Feddes Repert. 66: 151.

HUTH, ERNST. 1895. Monographie der Gattung *Delphinium*. Bot. Jahrb. Syst. 20: 322-499.

MARTIN, ROBERT F. 1938. *Delphinium carolinianum* and its allies. Bull. Torr. Bot. Club 65: 27-29.

PERRY, LILY M. 1937. Variants in two species of *Delphinium*. Rhodora 39: 20-22.

RADFORD, ALBERT E. et al. 1968. Manual of the Vascular Flora of the Carolinas. Chapel Hill.

SMALL, J. K. 1933. Manual of the Southeastern Flora. New York.

STUDIES IN THE RANUNCULACEAE OF THE SOUTHEASTERN UNITED STATES. V. RANUNCULUS L.[1,2]

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In providing a treatment of the Ranunculaceae for the forthcoming *Vascular Flora of the Southeastern United States*, a number of nomenclatural and taxonomic decisions were made which demand additional clarification. Throughout, this taxonomic treatment of *Ranunculus* is deliberately conservative and I have attempted specially to note those problem species deserving a thorough biosystematic study.

The cosmopolitan and heterogeneous genus *Ranunculus* is distinguished from other Ranunculaceae by its ensemble of alternate or basal leaves, non-spurred sepals, basally nectariferous petals, and achenes borne on relatively short fruiting receptacles. Within the southeastern United States, an area bounded by and including Louisiana, Arkansas, Kentucky, West Virginia, Maryland, and Delaware, I am recognizing 32 species of *Ranunculus*, as contrasted with over 400 species in the world (Buchheim, 1964) and 98 species for North America (Benson, 1948, 1954).

Aside from the earlier taxonomic treatments of the North American Ranunculi by Gray (1886) and Davis (1900), the only recent comprehensive treatment is by Benson who in a series of papers beginning in 1934, culminated his studies with a definitive treatment in 1948, followed by supplementary notes in 1954. Benson's work, largely followed in this paper, reflects mature scholarship and students of the North American Ranunculi will always be in his debt for his having so carefully laid the groundwork with respect to future biosystematic studies. (For an important recent taxonomic treatment of *Ranunculus* in Europe, including much pertinent biological information and a comprehensive list of references, see Dambolt, 1974). Nevertheless, with respect to the species in the southeastern United States, critical biosystematic studies (comparable to those by Harper, 1957; Fisher, 1965; Fisher et al., 1973) are needed in the *R. abortivus* complex (now underway at the University of North Carolina at Chapel Hill), the *R.*

[1] Based on a manuscript and notes compiled for the forthcoming *Vascular Flora of the Southeastern United States*. In general, the format follows Radford et al. (1967). Any suggestions for improving this treatment should be sent to me so that necessary corrections and additions can be made before the *Vascular Flora* is in press.

[2] Contribution No. 133 from the Department of Biology, The Pennsylvania State University.

SIDA 6(4): 266—283. 1976.

septentrionalis—*R. hispidus* group (currently being worked on at the University of Michigan), and the *R. pusillus* complex. Relative variation of *R. acris, R. bulbosus, R. ficaria,* and *R. repens* in North America should be studied, especially in comparison with populations of these species in Europe. Furthermore, chromosome counts for fourteen species (44 percent) have yet to be published (Table I).

Table I. List of Species for Which Chromosome Counts are Needed.

R. allegheniensis	*R. longirostris*
R. ambigens	*R. marginatus*
R. carolinianus	*R. micranthus*
R. flabellaris	*R. pensylvanicus*
R. harveyi	*R. platensis*
R. hispidus	*R. pusillus*
R. laxicaulis	*R. subcordatus*

Although it is not the purpose of this paper to analyze the variously proposed subgeneric groupings of this genus, one should note the wide divergence of opinion regarding a broad taxonomic treatment of the buttercups and water crowfoots. For example, Benson (1940) classified all North American species under the genus *Ranunculus sensu lato* which in turn was divided into nine subgenera, whereas Tamura (1967) divided *Ranunculus* into 15 different genera. However, in the opinion of Davis (1960) and Cook (1966) there is yet no satisfactory classification of *Ranunculus*. Therefore, in the following treatment, informal groups are adopted (which largely conform to various subgeneric divisions recognized by Benson, 1940; also cf. Davis, 1965) to facilitate determining unknown specimens to their proper species. It must be emphasized that *Ranunculus* is a critical genus and that in collecting plants one should obtain basal portions (including roots), mature fruit and flowers, together with notes on the habitat.

KEY TO GROUPS OF SPECIES

1. Sepals (3-)5(-6); petals typically 5; achenes smooth to spiny or pubescent, usually with well-developed beaks; leaves seldom entire-cordate.
   2. Petals usually glossy, yellow; achenes usually not transverse-ridged; terrestrial and aquatic herbs (subgen. *Ranunculus*).
      3. Leaves (especially the lower cauline) variously lobed to divided or compound.
         4. Basal leaves rarely deeply lobed, distinctly unlike the deeply parted cauline leaves; achenes turgid, ovoid, 1-2.5 mm long, without pronounced marginal rims . . . . . GROUP 1.
         4. Basal leaves mostly deeply parted or compound, usually similar to the smaller cauline leaves; achenes various, 2-5 mm long.
            5. Achenes markedly spiny, papillose or tuberculate . . GROUP 2.
            5. Achenes smooth or rarely pubescent or papillose.
               6. Achenes usually turgid, the marginal rims scarcely evident, corky-thickened below; marsh or aquatic plants . . GROUP 3.
               6. Achenes usually flattened, discoid, usually with pronounced marginal rims, not corky-thickened below; usually terrestrial plants . . . . . GROUP 4.

3. Leaves all simple, entire to denticulate or serrulate, not lobed or deeply divided.
   7. Pericarps smooth to verrucose, thick and firm; lower leaves linear to cordate-ovate; plants rarely stoloniferous . . . . GROUP 5.
   7. Pericarps longitudinally striate, facially 3 or more nerved, thin and fragile; leaves cordate-ovate to ovate; plants stoloniferous . . . . . GROUP 6.
2. Petals dull, white; achenes roughly transverse-ridged; aquatics with finely dissected to shallowly lobed leaves [subgen. *Batrachium* (DC.) A. Gray] . . . . . GROUP 7.
1. Sepals 3(-4); petals 7-12; achenes pubescent, beakless; leaves cordate [subgen. *Ficaria* (Huds.) L. Benson] . . . . . GROUP 8.

GROUP 1

1. Petals less than 3.5 mm long, equal to or shorter than the sepals; roots generally all filiform to some slightly fusiform-thickened.
   2. Achene beaks 0.1-0.3 mm long; petals longer than ½ length of the sepals; sepals glabrous to sparsely long-villous.
      3. Plants usually glabrous; basal leaves 1-6(10) cm wide, reniform to cordate; roots usually all filiform; receptacles usually villous . . . . . 1. R. ABORTIVUS.
      3. Plants villous, at least basally; basal leaves 1-2.5 cm wide, proximally truncate to cuneate (rarely cordate); some roots slightly fusiform-thickened; receptacles usually glabrous . . . 2. R. MICRANTHUS.
   2. Achene beaks 0.6-1 mm long; petals less than ½ length of the sepals; sepals hirsute . . . . . 3. R. ALLEGHENIENSIS.
1. Petals 6-8 mm long, distinctly longer than the sepals; some roots markedly fusiform-thickened. . . . . 4. R. HARVEYI.

GROUP 2

1. Flowers pedunculate, the peduncles usually elongating in fruit; sepals and petals usually 5.
   2. Petals 1-3 mm long; mature achenes papillate, each papilla with a slender hooked spine; receptacles glabrous. . . . 5. R. PRAVIFLORUS.
   2. Petals 4 mm or more long; mature achenes simply papillate to muricate or with straight to curved (not hooked) spines; receptacles pubescent.
      3. Achenes papillate or tuberculate (or often ± smooth), the bodies less than 3 mm long; achene beaks usually less than 0.5 mm long.
         4. Achene discs sparsely papillate to smooth; petals greater than 5 mm long; plants more or less hirsute . . . . . 6. R. SARDOUS.
         4. Achene discs with numerous small tubercles; petals less than 5 mm long; plants with a few scattered villous hairs . 7. R. TRILOBUS.
      3. Achenes conspicuously tuberculate or muricate to stout spiny, the bodies greater than 3 mm long; achene beaks at least (0.75)1 mm long.
         5. Achenes usually 10 or more, not in a single whorl; achene discs tuberculate to spiny, the margins smooth; largest leaves simple, broadly cordate to suborbicular and more or less 3-5 parted, the segments crenately lobed or toothed.
            6. Achene discs stout spiny or occasionally muricate; achene beaks at least 1.5 mm long; peduncles usually shorter than the subtending leaf; plants subglabrate . . . . . 8. R. MURICATUS.
            6. Achene discs tuberculate to muricate; achene beaks ca. 1 mm

long; peduncles usually longer than the subtending leaf; plants sparsely hispid . . . . . 9. R. MARGINATUS.
5. Achenes 9 or less, in a single whorl; achene discs and margins tuberculate to long spiny; largest leaves compound, the ultimate segments linear to obovate . . . . . 10. R. ARVENSIS.
1. Flowers sessile, axillary; sepals and petals 3 . . . 11. R. PLATENSIS.

GROUP 3

1. Petals 2-5 mm long; achenes essentially beakless (0.1 mm long); plants terrestrial to palustrine, without submersed leaves . . . . . 12. R. SCELERATUS.
1. Petals 7-15 mm long; achene beaks well-developed (0.6-1.5 mm long); plants aquatic with finely dissected submersed leaves . . . . . 13. R. FLABELLARIS.

GROUP 4

1. Petals small (2-4 mm long), about equalling the sepals.
2. Achene beaks markedly recurved; largest leaves merely deeply dissected; head of achenes globose . . . . . 14. R. RECURVATUS.
2. Achene beaks straight to slightly curved; largest leaves ternately compound; head of achenes elongated, cylindrical.
3. Sepals often 2 times as long as the petals; stems erect, not rooting at the lower nodes; achene beaks 0.5-1 mm long. . . . . 15. R. PENSYLVANICUS.
3. Sepals equal to or slightly shorter than the petals; stems ascending to trailing, frequently rooting at the lower nodes; achene beaks 1-1.5 mm long . . . . . 16. R. MACOUNII.
1. Petals large (5-18 mm long), distinctly longer than the sepals.
4. Achene beaks recurved or hooked, usually less than 1.5 mm long, stigmatose laterally.
5. Sepals spreading.
6. Stems repent, rooting at the lower nodes; basal leaves ternately compound; receptacles hispid . . . . . 17. R. REPENS.
6. Stems erect, never rooting; basal leaves deeply 5-parted; receptacles glabrous . . . . . 18. R. ACRIS.
5. Sepals tightly reflexed.
7. Plants perennial, cormose; petals 8-14 mm long; achenes smooth . . . . . 19. R. BULBOSUS.
7. Plants annual, soft-based; petals 5-8 mm long; achenes smooth to tuberculate . . . . . 6. R. SARDOUS.
4. Achene beaks straight to flexuous, (1)1.5-3 mm long, stigmatose apically.
8. Plants slender, erect, never stoloniferous, the roots ±fleshy-thickened; basal leaves both simple and compound, their stipules usually gradually tapering apically; mature achene bodies 1.5-3.5 mm long.
9. Roots ±uniform; later basal leaves generally cordate-ovate in outline, often broader than long, usually ternately lobed or divided; stem pubescence hispid, spreading to appressed 20. R. HISPIDUS.
9. Roots both long-filiform and relatively short-tuberous (1-5 mm thick); later basal leaves generally ovate-oblong in outline, often longer than broad, usually pinnately divided; stem pubescence silky-appressed . . . . . 21. R. FASCICULARIS.
8. Plants lax, often stoloniferous, the roots coarse-fibrous; basal leaves

usually all ternately compound, their stipules often broad, abruptly rounded or truncate apically; mature achene bodies 3-5 mm long.
10. Achenes 15-30, not broadly (0-0.3 mm) winged; petals rounded-obovate, 4-8 (13) mm wide; sepals spreading, longer than 2/3 length of petals; stems 2-8 mm in diameter, usually spreading-hispid . . . . . 22. R. SEPTENTRIONALIS.
10. Achenes 7-15, broadly (0.5-1 mm) wing-keeled; petals oblong, 2-5(8) mm wide; sepals usually reflexed, about ½ length of petals; stems 1-3 mm in diameter, subglabrous to appressed- or spreading-hispid. . . . . 23. R. CAROLINIANUS.

GROUP 5

1. Petals 1-3, about equalling the sepals; annuals. . . . 24. R. PUSILLUS.
1. Petals (4)5-9, distinctly longer than the sepals; annuals or perennials.
  2. Largest cauline leaves lanceolate to oblong-ovate; achene faces smooth to finely reticulate-pitted.
    3. Plants annuals with basal leaves; achenes ca. 0.6 mm broad, their beaks 0.1-0.2 mm long; sepals 1.5-2.5 mm long; blades of largest leaves usually less than 6 cm long. . . . . 25. R.LAXICAULIS.
    3. Plants perennials with no basal leaves; achenes ca. 1.4 mm broad, their beaks 0.5-1.3 mm long; sepals ca. 4 mm long; blades of largest leaves at least 6 cm long. . . . . 26. R. AMBIGENS.
  2. Largest cauline leaves cordate to subcordate; achene faces verrucose. . . . . 27. R. SUBCORDATUS.

GROUP 6

One species . . . . . 28. R. CYMBALARIA.

GROUP 7

1. Leaves floating, shallowly lobed; receptacles glabrous. . . . . 29. R. HEDERACEUS.
1. Leaves usually submersed, finely dissected; receptacles hispid.
  1. Leaves about as long as the adjacent internode, usually flaccid and generally collapsing when removed from the water; free petioles usually as long as the dilated stipular base; achene beaks absent or shorter than 0.3 mm long. . . . . 30. R. TRICHOPHYLLUS.
  2. Leaves usually much shorter than the adjacent internode, firm, not collapsing when removed from the water; free petioles absent or at least much shorter than the dilated stipular base; achene beaks 0.7-1.1 mm long. . . . . 31. R. LONGIROSTRIS.

GROUP 8

One species . . . . . 32. R. FICARIA.

GROUP 1

1. R. ABORTIVUS L., Small-flowered Crowfoot

Rich low woods, low fields and moist waste places; all prov. SE. [ALL]. Incl. *R. a.* var. *indivisus* Fern.—Fernald (1950), a form with undivided cauline leaves.

Ranunculus abortivus, the most widespread and common species within a complex of four apparently closely related species (nos. 1-4), is quite variable leading Fernald (1899, 1938) to describe several varieties. Only

one of these varieties (var. *indivisus*) occurs within the southeastern United States; it is restricted to the Nottoway River system in southeastern Virginia (Fernald, 1938). Although I am regarding var. *indivisus* of doubtful status (cf. Benson, 1948: a "rather questionable variety"), mass collections (cf. Fassett, 1942; note that Fassett did not sample populations of *R. abortivus* within Virginia) of this species within the southeastern United States would be desirable.

2. R. MICRANTHUS Nuttall

Rich woods, rocky hillsides, and calcareous banks; chiefly pied. and mts. Ark., Ky., Md., N.C., Tenn., Va., W.Va. [ALL except Tex.]. Incl. *R. m.* var. *delitescens* (Greene) Fern.—Fernald (1950), a pale green form with the simple basal leaves having relatively fewer teeth and cuneate to truncate bases.

Fernald (1939) recognized three varieties, one [var. *cymbalistes* (Greene) Fern.] restricted to Indiana, the other two widely ranging in the eastern United States. The two eastern varieties are distinguished chiefly by leaf shape and texture—var. *delitescens* (Greene) Fern. with pale green dull foliage and proximally subtruncate to cuneate basal leaves and var. *micranthus* with darker green lustrous foliage and subcordate to cordate basal leaves. There does not seem to be any marked geographic pattern conformable to these two morphs, however, and I am following Benson (1948) in treating *R. micranthus* as one polymorphic species, although Fassett (1942) suggested that mass collections throughout the range might throw light on the validity of segregating any geographically-based or ecotypic varieties.

3. R. ALLEGHENIENSIS Britton

Rich woods and calcareous slopes; chiefly mts. Md., N.C., Tenn., Va., W.Va. [Ohio, Pa.].

4. R. HARVEYI (Gray) Britton

Low woods, bluffs and ravines, rare; all prov. Ala., Ark., Tenn. [Okla., Mo., Ill.].

This is a distinct and relatively invariant species with a limited range in south-central United States. Occasional forms are strongly pilose which have been segregated as var. *pilosus* Benke (1928). Field studies should be pursued to establish population variability especially in view of assessing any geographic correlation with the degree of pubescence.

GROUP 2

This Group (nos. 5-11; = section *Echinella* DC.—Benson, 1948) are naturalized annuals native to Europe, western Asia, and South America (*R. platensis*). They are characterized principally by their more or less discoid achenes facially covered with papillae, tubercles, straight to curved spines,

or slender hooks. Several of these weedy introductions are rare (*R. marginatus, R. platensis, R. trilobus*) whereas two species especially (*R. parviflorus, R. sardous*) are widespread and relatively common weeds of fields and waste places.

5. R. PARVIFLORUS L.

Fields and waste places; chiefly cp. and pied. SE except Del. and W.Va. [Tex., Okla., Mo.].

For a detailed study of the morphology and ecology of this species in Europe see Salisbury (1931).

6. R. SARDOUS Crantz

Low fields and waste places; chiefly cp. and pied. Ala., Ark., Ga., Ky., La., Miss., N.C., S.C., Tenn., Va. [Mo., Ill., Pa., N.J.]. *R. parvulus* L.—Small (1933).

Ranunculus sardous can be confused with *R. bulbosus*, but the former species is distinguished by its annual habit, soft-based noncormose stems, smaller flowers, and typically papillose or tuberculate achene discs (faces).

7. R. TRILOBUS Desf.

Low clearings and roadsides, very rare; cp. Fla., La.

This species was first reported for the United States by Shinners (1960) who collected it in April, 1960, in Louisiana; it has since been collected in Florida by R. K. Godfrey (FSU!).

8. R. MURICATUS L.

Low meadows, ditches and stream banks; cp., rarely pied. Ala., Ark., La., Miss., S.C. [Tex.].

9. R. MARGINATUS d'Urv.

Roadside ditches, very rare; cp. La.

This is another species first reported for the United States by Shinners (1962). Superficially it resembles the more common *R. muricatus* but *R. marginatus* has a more pubescent habit, tuberculate or muricate achene discs and shorter achene beaks (cf. key to Group 2, above). In his report, Shinners (1962) determined his material as *R. trachycarpus*, but in this paper I am following Tutin (1964) and Davis (1965) in determining our material as *R. marginatus* although specimens with tuberculate or muricate achene discs can be distinguished as variety *trachycarpus* (Fisch. & Meyer) Azn.

10. R. ARVENSIS L.

Fields and waste ground, uncommon; chiefly cp. and pied. Ga., Miss., N.C., S.C. [Mo., Ohio, N.J.]. Incl. var. *tuberculatus* (DC.) Koch—Radford (1968).

The sculpturing of the achenes in this species is quite variable which has led to the segregation of a number of varieties by earlier European workers (Dambolt, 1974). Inasmuch as single populations often are polymorphic (Davis, 1965), I am not giving formal recognition to the major variants in our flora (cf. Ahles et al., 1958), a practice currently followed by Tutin (1964), Davis (1965), and Dambolt (1974).

11. R. PLATENSIS Sprengel

Sandy clearings along streams, very rare; cp. Fla., La. [Tex.].

GROUP 3

12. R. SCELERATUS L.

Marshes, wet ditches, lake and stream banks; cp. and pied. SE except Ark. [ALL].

13. R. FLABELLARIS Raf., Yellow Water Crowfoot

Shallow water and muddy shores, rare; chiefly cp. Ala., Ark. cp and mts., Del., La., N.C., Va. [ALL except Tex.]. *R. delphinifolius* Torrey—Small (1933).

Heterophylly in this species is apparently controlled by temperature, photoperiod, and whether the leaf primordia developed in a submerged or terrestrial environment (Bostrack and Millington, 1962).

GROUP 4

14. R. RECURVATUS Poiret, Hooked Buttercup

Rich low woods; all prov. SE. [ALL]. Incl. *R. r.* var. *adpressipilis* Weath.—Fernald (1950), a form with scattered, closely adpressed cauline hairs.

The pubescence of this species is variable (lower stems ± glabrous; stems with strongly villous 2-3 celled hairs; stems with unicellular appressed hairs) leading Weatherby (1929) to describe several infraspecific taxa. Population studies assessing the degree of polymorphism would be desirable, and pending such work I consider Weatherby's taxa of doubtful taxonomic significance.

15. R. PENSYLVANICUS L.f., Bristly Crowfoot

Marshes, wet woods and meadows, rare; cp. Del. [ALL except Tex., Okla., Mo.].

16. R. MACOUNII Britton

Marshes, very rare; mts. Pendleton Co., W.Va. A northern species, widely disjunct in our area (see Hutton, 1971).

17. R. REPENS L., Creeping Buttercup, Swamp Buttercup

Low meadows, stream banks, waste places; all prov. Del., Ky., Md., N.C.,

S.C., Tenn., Va., W. Va. [ALL except Okla.] Incl. *R. r.* var. *pleniflorus* Fern.—Fernald (1950). A variable species; double-flowered forms (var. *pleniflorus*) frequently escape from cultivation.

Ranunculus repens and its allies (nos. 17, 18, 19) are European introductions now widely scattered in North America. The demography and floral biology of all three species have been thoroughly studied in England by John Harper and his associates (see especially Harper, 1957; Sarukhán and Harper, 1973) and smiliar studies on North American populations would be desirable especially from a comparative evolutionary standpoint.

The swamp buttercup is very variable, a fact leading Fernald (1919) to recognize six varieties. At present, I am following European workers (Tutin, 1964; Davis, 1965; Dambolt, 1974) who regard *R. repens* as one polymorphic species, although I agree with Tutin (1964) that it is "much in need of detailed investigation."

18. R. ACRIS L., Tall Buttercup

Pastures, meadows, clearings and waste places; all prov. Del., Ga. pied., Md. cp., N.C., S.C., Tenn., Va., W.Va. [ALL except Tex. and Okla.].

Ranunculus acris is an exceedingly variable complex in Europe and Asia (Hara and Kurosawa, 1956; Tutin, 1964; Coles, 1971), varying chiefly with regard to overall height, type of rootstock, leaves (shape, lobing, texture), pubescence (stems, leaves, filaments), number of flowers, and achenes (size, shape, length of beak) (Tutin, 1964). On the other hand, students of North American Ranunculi (e.g. Benson, 1948) generally regard the plants of eastern North America as one taxon. Comparative studies (such as those by Coles, 1971) of scattered populations in North America would be most useful, especially in view of the considerable variability of the Old World material.

19. R. BULBOSUS L., Bulbous Buttercup

Fields, roadsides, and pastures; all prov. Ala., Ark., Del., Ga., La., Md., N.C., S.C., Tenn., Va., W.Va. [ALL except Tex. and Okla.]. Incl. *R. b.* var. *valdepubens* (Jordan) Briquet, *R. b.* var. *dissectus* Bailey—Fernald (1950).

Ranunculus bulbosus is another variable species native to the Old World and which over the years has been subjected to excessive splitting into species and infraspecific taxa (Coles, 1973). For example, in the *Flora Europaea,* Tutin (1964) recognized 6 subspecies based on variations in the leaves, corms, roots, plant heights, and pubescence. However, Coles (1973) has recently studied the *R. bulbosus* complex in Europe and she concluded there are only two subspecies: subsp. *bulbosus* with well-formed corms, thin roots, compound basal leaves with stalked terminal segments and fine petiolar hairs and subsp. *adscendens* (Brot.) Neves, with scarcely cormose rootstocks, tuberous roots, simple basal leaves, and coarse petiolar hairs.

Within the southeastern United States, such a division does not appear to be correlated with either geography or ecology and therefore I am following Benson (1948) in recognizing *R. bulbosus* as a single variable species, although thorough field studies may lead to a revision of this interpretation.

The *R. septentrionalis—R. hispidus* complex (nos. 20-23) is an extremely critical group (cf. Benson, 1962). Within the southeastern United States there are four polymorphic species in this complex plus a number of segregate infraspecific taxa (Benson, 1948). With adequate material, the species usually can be distinguished (Table II), although intergradient forms occur. In collecting specimens, special care should be exercised in securing mature plants with flowers and fruits, basal leaves, roots, and any stoloniferous branches (in nos. 22, 23).

20. R. HISPIDUS Michaux, Hispid Buttercup

Dry rocky to rich moist woods; all prov. Ala., Ark., Ga., Ky., Md., Miss., N.C., S.C., Tenn., Va., W.Va. [ALL]. Incl. *R. h.* var. *falsus* Fern.—Fernald (1950); *R. h.* var. *marilandicus* (Poiret) Benson—Gleason and Cronquist (1963); *R. h.* var. *eurylobus* Benson—Fernald (1950), Gleason and Cronquist (1963). A highly variable species in need of critical study.

According to Benson (1948) there are four varieties of *R. hispidus* (for photographs of all four varieties, see Benson, 1962, Figs. 2-15, 16), based chiefly on variations in pubescence, basal leaf shape, size, and division, and flowering period. Inasmuch as the geographic ranges considerably overlap (Benson, 1962, Fig. 2-17) and because the ecological requirements as well as the population variability of these infraspecific segregates are not sufficiently well understood at the present time, I am regarding *R. hispidus* as a single polymorphic species.

21. R. FASCICULARIS Muhl. ex Bigel.

Prairies, thin dry woods and exposed calcareous slopes and ledges; chiefly cp. and pied. Ala., Ark., Ky., La., Md. mts., Miss., S.C., Tenn., Va. [ALL except N.J.]. Incl. *R. f.* var *apricus* (Greene) Fern.—Fernald (1950), a form with less divided leaves.

Greene (1900) described the smaller and simpler-leaved plants of south-central United States as *R. apricus*, later reduced by Fernald (1936) to a variety under *R. fascicularis*. Although this segregate might well be given taxonomic recognition, because of numerous intermediates I prefer to regard the southern form as an extreme variant within an apparent ecocline ranging throughout eastern North America.

22. R. SEPTENTRIONALIS Poiret, Northern Swamp Buttercup

Low woods, marshes, meadows and alluvial thickets; all prov. Ark., Ga., Ky., Md., N.C. mts., Tenn. mts., Va., W.Va. [ALL except Tex. and Okla.].

Table II. Comparison of Species in the *R. septentrionalis*—*R. hispidus* Complex*

Characteristic	*R. septentrionalis*	*R. carolinianus*	*R. hispidus*	*R. fascicularis*
Height (dm)	2-6	1.5-6	1-4	1-3
Stoloniferous	+	+	—	—
Stem pubescence	±Spreading-hispid	Subglabrous to spreading-hispid	Hispid	Appressed-hispid or pilose
Roots	Fibrous	Fibrous	±Fleshy	Filiform and tuberous
Basal leaves	All compound	(Simple) Compound	Simple and compound	Simple and compound
Later basal leaves	Ternate	Ternate	Ternately lobed or divided	Pinnately divided
Stipular leaf bases	Broad, apically truncate to rounded		Long, narrow, apically ±tapering	
Sepals:				
habit	Spreading	Reflexed	Spreading	Spreading
length (mm)	6-11	3.5-5(7)	4-6	6-8
Petals:				
shape	Rounded-obovate	Oblong	Obovate to oblong	Linear-oblong to obovate
length (mm)	8-12	7-12	9-13	7-15
Carpel number	15-30	7-15	12-30	10-30
Achene margins	Keeled	Winged (wings ca. 1 mm high)	Narrowly keeled	Keeled
Chromosome number (n=)	16, 32 (?)	—	16	16
Habitat	Low woods, marshes, meadows and alluvial thickets	Low woods, thickets, marshes	Dry rocky ground, rich moist woods	Thin dry woods, exposed calcareous ledges
Range	N.D. to Lab., s. to Ga., Tenn., and Ark.	Minn. to Pa., s. to n. Fla., and w. to Tex.	S.D. and Neb. to Mass., s. to Ga., Ala. and Ark.	Minn. to Mass., s. to S.C., Ala., Miss., La., and Tex.

* Based in part on Benson (1948).

Incl. *R. s.* var. *caricetorum* (Greene) Fern.—Fernald (1950), a form with the petioles and lower internodes densely retrorsely-hispid; incl. *R. carolinianus* DC.—*sensu* Radford (1698), *pro parte.*

The form with densely retrorsely-hispid petioles is not associated with other characters (Benson, 1948) and does not appear to warrant taxonomic recognition.

23. R. CAROLINIANUS DC.

Low woods, thickets and marshes; all prov. Ala., Ark., Fla., Ga., N.C., S.C., Tenn., Va., W.Va. [Tex., Okla., Mo., Ill., Pa.]. *R. septentrionalis* Poiret var. *pterocarpus* Benson—Gleason and Cronquist (1963); *R. palmatus sensu* Small, *non* Ell.—Small (1933); *R. carolinianus* DC.—*sensu* Radford (1968), *pro parte.*

Some authors (e.g., Radford, 1968) lump *R. septentrionalis* and *R. carolinianus* or else regard *R. carolinianus* as a variety (var. *pterocarpus* Benson) of *R. septentrionalis* (e.g. Gleason and Cronquist, 1963). Pending additional study I am presently following Benson (1948) in recognizing *R. carolinianus* as a distinct species. Nevertheless, it is not always clearly distinct from *R. septentrionalis* and collectors should take special care to secure specimens with mature achenes.

GROUP 5

Plants of the *R. pusillus—R. ambigens* group [section *Flammula* (Webb) Ruoy & Faucaud] generally occur in low wet areas. As a group, these species are distinguished by their 5 sepals, variable number of yellow petals, simple entire to denticulate or serrulate leaves, and smooth to papillose or verrucose achenes. Although the species can usually be separated (Table III), several species are quite polymorphic and the group as a whole deserves a careful population and experimental taxonomic study, including chromosome counts which are lacking for all four species. The nomenclature in this complex is confused, and I have tried to rectify matters in Table IV.

24. R. PUSILLUS Poiret

Low wet grounds and shallow pools; chiefly cp. and pied. SE. [ALL]. Incl. *R. lindheimeri* Engelm., *R. tener* Mohr—Small (1933).

The widespread *R. pusillus* is quite variable, leading Small (1933) to recognize three species, differentiated chiefly by the shape of the fruiting heads (globose to cylindrical) and achene texture (smooth to papillose). It appears that within the southeastern United States particularly in the western portion of the range (cf. Table III), the fruiting heads tend to become elongated and the achenes papillose [= *R. tener* Mohr; var. *angustifolius* (Engelm.) Benson]. However, until field studies are undertaken to analyze the variability of local populations as well as possible relative geo-

Table III. Comparison of Species in the *R. ambigens*—*R. pusillus* Complex*

Characteristic	*R. ambigens*	*R. laxicaulis*	*R. pusillus*	*R. subcordatus*
Habit	Perennial	Annual	Annual	Perennial
Basal leaves	Absent	Present	Present	Absent
Cauline leaves:				
shape	±Lanceolate	Lance-ovate to oblong	Lance-ovate to suborbicular	±Cordate
margin	Usually denticulate	±Entire	Entire to denticulate	Entire to denticulate
length (cm)	6-14	1-6	1-5	1-3.5
Sepal length (mm)	4	1.5-2.5	1-2	1.9-2.2
Petals:				
number	5(-6)	5(-10)	1-3	4-8
length (mm)	5-7	3-4(9)	1-1.5	3-4
Achenes:				
body length (mm)	2	0.6-0.7	1	1
beak length (mm)	1-1.3	0.1-0.2	0.1-0.2	0.1-0.2
texture of disc	Smooth or finely reticulate	Smooth	Smooth to papillate	Verrucose
Range	Minn. to Maine, s. to S.C., Tenn., and La.	Kans. to Ind. and Del., s. to S.C. Tenn., Ark. and Tex.	Mo. to N.Y., s. to Fla. and Tex.; disjunct in Calif.	Rare, N.C.

* Based in part on Benson (1948) and Beal (1971).

Table IV. Nomenclature of *R. ambigens*, *R. laxicaulis*, and *R. pusillus*

Benson (1948, 1954)	Radford (1968)	Fernald (1950)	Gleason and Cronquist (1963)	Small (1933)
1. *R. ambigens* Wats.	*R. ambigens*	*R. ambigens*	*R. ambigens*	*R. obtusiusculus* Raf.
2. *R. laxicaulis* (T. & G.) Darby	*R. laxicaulis*	*R. laxicaulis*	*R. texensis* Engelm.	*R. mississippiensis* Small
				R. oblongifolius sensu Small, *non* Elliott
3. *R. pusillus* Poiret				
a. var. *pusillus*	*R. pusillus*	*R. pusillus*	*R. pusillus*	*R. pusillus* *R. lindheimeri* Engelm.
b. var. *angustifolius* (Engelm.) Benson				*R. tener* Mohr

graphic discontinuities, I prefer to regard *R. pusillus* as a single widespread polymorphic species.

25. R. LAXICAULIS (Torrey & Gray) Darby

Marshes and ditches; chiefly cp. Ark., Del., La., Md., S.C., Tenn., Va. [Tex., Okla., Mo., Ill., Ind.]. *R. oblongifolius sensu* Small, *non* Ell.—Small (1933); *R. texensis* Engelm.—Gleason and Cronquist (1963); incl. *R. mississippiensis* Small—Small (1933).

26. R. AMBIGENS Watson

Low wet grounds and shores; chiefly cp. and pied. Ala., Del., La., Md., N.C., S.C., Tenn., Va., W.Va. [Ohio, Pa., N.J.]. *R. obtusiusculus* Raf.—Small (1933).

27. R. SUBCORDATUS E. O. Beal

Marshy shores and wooded streams, rare; cp. N.C.

Beal (1971) recently described this species from the Coastal Plain of North Carolina. It appears to be closely related to *R. bonariensis* Poiret of South America (Beal, 1971), but is relatively distinct from other species in the *R. pusillus—R. ambigens* group (nos. 24-26). *R. subcordatus* is known only from Bladen and Halifax Counties, North Carolina, and collectors are advised to look for it elsewhere in the Coastal Plain of the southeastern United States.

GROUP 6

28. R. CYMBALARIA Pursh, Seaside Crowfoot

Marshes and muddy shores, rare; cp. Ark. [Tex., Okla., Mo., Ill., N.J.].

GROUP 7

The batrachian Ranunculi (nos. 29-31 in this treatment) have long been considered a difficult group, doubtless due to their marked phenotypic plasticity. Nevertheless, a number of revisions have been attempted (e.g. Drew, 1936; Benson, 1948), the most recent by Cook (1966) whose treatment I am following with respect to the taxonomy of the Batrachia of the southeastern United States. I am also following Cook (1963, 1966) in regarding the batrachian Ranunculi as a subgenus of *Ranunculus*, although the group is often treated as a separate genus (e.g. Small, 1933; Tamura, 1967). As Cook (1963, 1966) points out, however, *Batrachium* cannot be separated from *Ranunculus* by any single character and therefore he argued for its retention within *Ranunculus*. The batrachian Ranunculi typically are aquatics with laminate or capillary leaves, white petals and transversely-ridged achenes.

29. R. HEDERACEUS L.

Fresh water aquatic; cp., rarely farther inland. Md., N.C., S.C., Va. [Pa.].

30. R. TRICHOPHYLLUS Chaix, White Water Crowfoot

Fresh water aquatic, rare; mts. Ky., W.Va. [Pa., N.J.]. *Batrachium flaccidum* (Persoon) Rupr.—Small (1933); *R. aquatilis* L. var. *capillaceus (Thuillier)* DC.—Gleason and Cronquist (1963).

GROUP 8

31. R. LONGIROSTRIS Godron

Aquatic in sluggish fresh water, rare. Ala. cp., Del. cp., Va. pied. [ALL]. *Batrachium trichophyllum sensu* Small, *non* Chaix—Small (1933).

32. R. FICARIA L., Lesser Celandine

Cultivated plant, occasionally escaped to open woods and waste places, rare; cp. Md., Tenn., Va., W.Va. [Pa., N.J.].

Ranunculus ficaria is a polymorphic and cytologically complex species (Greene and Thomas, 1961; Gill et al., 1972; Marchant and Brighton, 1974) with a number of unusual features (cordate leaves, 3 sepals, 7-21 yellow petals, pubescent beakless achenes and markedly unequal cotyledons) leading some taxonomists (e.g. Tamura, 1967) to segregate these plants as a separate genus. There can be no doubt that *Ranunculus s.l.* should be thoroughly revised and the species reclassified (cf. Davis, 1965; Cook, 1966), but pending such work, I prefer to regard *R. ficara* as a species in *Ranunculus*.

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REFERENCES

AHLES, H. E., C. R. BELL, and A. E. RADFORD. 1958. Species new to the flora of North or South Carolina. Rhodora 60: 10-32.

BEAL, E. O. 1971. A new species of *Ranunculus* from North Carolina. Brittonia 23: 266-268.

BENKE, H. 1928. Two new varieties of early spring plants—a *Ranunculus* from Missouri and a *Heterotheca* from Texas. Rhodora 30: 200-201.

BENSON, L. 1936. Pacific states Ranunculi, I & II. Amer. J. Bot. 23: 26-33, 169-176.

_____. 1940. The North American subdivisions of *Ranunculus*. Amer. J. Bot. 27: 799-807.

_____. 1948. A treatise on the North American Ranunculi. Amer. Midl. Nat. 40: 1-261.

_____. 1954. Supplement to a treatise on the North American Ranunculi. Amer. Midl. Nat. 52: 328-369.

_____. 1962. Plant taxonomy. Ronald Press, New York.

BOSTRACK, J. M. and W. F. MILLINGTON. 1962. On the determination of leaf form in an aquatic heterophyllous species of *Ranunculus*. Bull. Torrey Bot. Club. 89: 1-20.

BUCHHEIM, G. 1964. Ranunculaceae, p. 133-137. *In* H. Melchior (ed.), A. Engler's Syllabus der Pflanzenfamilien, Band II, Auflage 12. Gebrüder Borntraeger, Berlin-Nikolassee.

COLES, S. M. 1971. The *Ranunculus acris* complex in Europe. Watsonia 8: 237-262.
_____. 1973. *Ranunculus bulbosus* L. in Europe. Watsonia 9: 207-228.
COOK, C. D. K. 1963. Studies in *Ranunculus* subgenus *Batrachium* (DC.) A. Gray. II. General morphological considerations in the taxonomy of the subgenus. Watsonia 4: 294-303.
_____. 1966. A monographic study of *Ranunculus* subgenus *Batrachium* (DC.) A. Gray. Mitt. Bot. Staatssamml. München 6: 47-237.
DAMBOLT, J. 1974. *Ranunculus*, p. 232-317. *In* G. Hegi: Illustrierte Flora von Mittel-Europa, ed. 2. Bd. III (Teil 3, Lief. 2/3, 4/5). Carl Hanser, München.
DAVIS, K. C. 1900. Native and cultivated Ranunculi of North America and segregated genera. Minn. Bot. Stud. 2: 459-507.
DAVIS, P. H. 1960. Materials for a flora of Turkey: IV. Ranunculaceae II. Notes Roy. Bot. Gard. Edinb. 23: 103-161.
_____. (ed.). 1965. Flora of Turkey, Vol. 1, Edinburgh Univ. Press, Edinburgh.
DREW, W. B. 1936. The North American representatives of *Ranunculus* § *Batrachium*. Rhodora 38: 1-47.
FASSETT, N. 1942. Mass collections: *Ranunculus abortivus* and its close allies. Amer. Midl. Nat. 27: 512-522.
FERNALD, M. L. 1899. Two plants of the crowfoot family. Rhodora 1: 48-52.
_____. 1919. The variations of *Ranunculus repens*. Rhodora 21: 169.
_____. 1936. Contributions from the Gray Herbarium of Harvard University—No. CXIII. III. Memoranda on *Ranunculus*. Rhodora 38: 171-178.
_____. 1938. Noteworthy plants of southeastern Virginia. Rhodora 40: 364-424.
_____. 1939. Last survivors in the flora of Tidewater, Virginia. Rhodora 41: 465-504, 529-558, 564-575 (541-544 on *Ranunculus*).
_____. 1950. Gray's manual of botany, 8th ed. American Book Co., New York.
FISHER, F. J. F. 1965. The alpine Ranunculi of New Zealand. N.Z. Dept. Sci. Industrial Res. Bull. 165. Government Printer, Wellington.
_____, J. A. ROWLEY, and C. J. MARCHANT. 1973. The biogeography of the western snow-patch Ranunculi of North America. C. R. Soc. Biogéogr. 438: 32-43.
GILL, J. J. B., B. M. G. JONES, C. J. MARCHANT, J. McLEISH, and D. J. OCKENDON. 1972. The distribution of chromosome races of *Ranunculus ficaria* L. in the British Isles. Ann. Bot. (Lond.) 36(144): 31-47.
GLEASON, H. A. and A. CRONQUIST. 1963. Manual of vascular plants of northeastern United States and adjacent Canada. D. Van Nostrand Co., Princeton, N.J.
GRAY, A. 1886. A revision of the North American Ranunculi. Proc. Amer. Acad. 21: 363-378.
GREEN, P. S. and J. L. THOMAS. 1961. The bulbiferous *Ranunculus ficaria*. Rhodora 63: 289-291.
GREENE, E. L. 1900. Some new or critical Ranunculi. Pittonia 4: 142-146.
HARA, H. and S. KUROSAWA. 1956. Cytotaxonomical notes on the *Ranunculus acris* group in Japan. Bot. Mag. Tokyo 69: 345-352.
HARPER, J. L. 1957. Biological flora of the British Isles: *Ranunculus acris* L., *Ranunculus repens* L., and *Ranunculus bulbosus* L. J. Ecol. 45: 289-342.
HUTTON, E. 1971. Plants previously unknown in West Virginia. Castanea 36: 166-167.
MARCHANT, C. J. and C. A. BRIGHTON. 1974. Cytological diversity and triploid frequency in a complex population of *Ranunculus ficaria* L. Ann. Bot. (Lond.) 38(154): 7-15.
RADFORD, A. E. 1968. Ranunculaceae, p. 452-468. *In* A. E. Radford, H. E. Ahles, and C. R. Bell, Manual of the vascular flora of the Carolinas. Univ. of North Carolina Press, Chapel Hill, N.C.
_____., C. R. BELL, J. W. HARDIN, and R. L. WILBUR. 1967. Contributor's guide for the vascular flora of the southeastern United States. Dept. of Botany, Univ. of North Carolina, Chapel Hill.
SALISBURY, E. J. 1931. On the morphology and ecology of *Ranunculus parviflorus* L. Ann. Bot. (Lond.) 45: 539-578.
SARUKHAN and J. L. HARPER. 1973. Studies on plant demography: *Ranunculus repens* L., *R. bulbosus* L. and *R. acris* L. I. Population flux and survivorship. J. Ecol. 61: 675-716.

SHINNERS, L. H. 1960. *Ranunculus trilobus* (Ranunculaceae) in southern Louisiana: new to the United States. Southwestern Nat. 5(3): 170.

———. 1962. *Ranunculus trachycarpus* (Ranunculaceae) in south-central Louisiana: new to North America. Sida 1: 104-105.

SMALL, J. K. 1933. Manual of the Southeastern flora. Publ. by the author, New York.

TAMURA, M. 1967. Morphology, ecology and phylogeny of the Ranunculaceae. VII. Sci. Rep. Osaka Univ. 16: 21-43.

TUTIN, T. G. 1964. *Ranunculus*, subgen. *Ranunculus*, p. 223-237. *In* T. G. Tutin et al. (eds.), Flora Europaea, Vol. 1. Cambridge Univ. Press, London.

WEATHERBY, C. A. 1929. Two variants of *Ranunculus recurvatus*. Rhodora 31: 163-164.

TAXONOMY OF THE GENUS POLYGALA SERIES DECURRENTES (POLYGALACEAE)[1]

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ABSTRACT

A taxonomic revision of POLYGALA series DECURRENTES is presented, based upon evidence from morphology, chromosome numbers, habitat, and distribution. Seven species, one with two varieties, are recognized. All are native to the southeastern United States. Each species is illustrated with line drawings showing habitat and floral morphology; distribution maps indicate sites of known populations. Selected specimens are cited, representative of the 2,463 examined. POLYGALA BALDUINII var. **carteri** (Small) Smith & Ward is proposed as a new combination, and POLYGALA **smallii** Smith & Ward is proposed in place of the illegitimate *P. arenicola* Small.

The genus *Polygala* L. is widely distributed in the tropical and temperate regions of the world. It is absent only in New Zealand, Polynesia, and the arctic regions of North America and Asia. Approximately 475 species of *Polygala* have been described; of these, 127 species occur in North America, excluding the Caribbean, with about 50 in the United States. Series *Decurrentes*, a natural grouping of seven species of the Southeastern Coastal Plain, known by Small (1933) as the genus *Pilostaxis* Raf., is here revised.

The numerous species in the genus *Polygala* exhibit a morphological diversity that is accommodated only by the use of hierarchical subgeneric classification. Three ranks may be usefully recognized below the level of genus and above that of species. Chodat (1893, 1896) divided the North American species into four sections, the largest of which is his *Orthopolygala*, containing the type of the genus (*P. vulgaris* L.) and now under Art. 22 of the International Code known as sect. *Polygala*. This section is characterized by the presence on the abaxial petal (keel) of a lacerate or fimbriate crest, and by sepals that persist in fruit. Within sect. *Polygala* Chodat recognized three subsections, two of them found in North America, and weakly distinguished by the degree to which the cells of the capsule are margined or winged. Those species with unwinged capsules or with the two cells narrowly and equally margined were placed in subsect. *Apterocarpae*, again the largest taxon. Within this subsection Chodat described several series, among the most natural of these being ser. *Decur-*

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rentes, in which the sepals are decurrent, forming narrow wings along the pedicels and onto the adjacent inflorescence axis.

The first species of *Polygala* ser. *Decurrentes* to bear a legitimate name was *P. lutea* (1753), typified by two slender plants received by Linnaeus from Peter Kalm, his correspondent and agent in the New World. Kalm undoubtedly made his collection near Swedesboro (then Raccoon), New Jersey, his home in the spring of 1749, and close to the northern limit of this most far ranging member of the series. Other species were described by Thomas Walter (1788) from the vicinity of his rice and indigo plantation on the Santee River, Berkeley County, South Carolina (*P. cymosa*), by Andre Michaux (1803) from a moist meadow in the Carolinas (*P. nana*), by Thomas Nuttall (1818) from a specimen received in correspondence from near the mouth of the St. Mary's River, northeastern Florida (*P. balduinii*), by Stephen Elliott (1822) from coastal South Carolina (*P. ramosa*), by A. W. Chapman (1887) from Tampa Bay, western peninsular Florida (*P. rugelii*), and by J. K. Small (1905) from pinelands near Cutler, Dade County, Florida (*P. smallii*).

These species were not immediately recognized to constitute a natural grouping within the genus *Polygala*. Nuttall revealed some awareness of relationships by arranging three of the four species treated by him in one numerical sequence, although *P. lutea* was placed separately. Elliott was familiar with five species which he listed consecutively but otherwise without separation from other members of the genus. DeCandolle (1824) treated *P. lutea* and *P. nana* apart from the other species now in the *Decurrentes*, and Torrey and Gray (1838), also not completely aware of the naturalness of the group, did likewise.

Rafinesque, again a resident of Philadelphia after his self-imposed exile to pioneer Kentucky, but still an outcast from the scientific community, first gave nomenclatural recognition to a grouping of the above species. His genus *Pilostaxis* (1838) contained only *P. lutea*, designated as the type, and *P. nana* (which he saw as two species), and was superficially or even erroneously characterized by capitate inflorescences and stamens in 4's (rather than 6-8's). Perhaps more for reasons of hauteur by the botanical establishment than from awareness of the inadequacies of his treatment, Rafinesque's *Pilostaxis* was disregarded for nearly one hundred years until disinterred by Small (1933).

It remained for the versatile Swiss botanist Robert Chodat, then rising through the ranks of the University of Geneva and wholly isolated from living North American *Polygala*, to recognize (1893) that several of the species often placed together on general appearance, shared the characteristic of sepals that were decurrent on the pedicel. He placed the species with this property in his series *Decurrentes*. But the equally astute Blake (1924), an American with field experience, although continuing the close placement of these species, gave the group no formal designation. Recent workers with

the Polygalaceae in the southeastern United States have given little attention to subgeneric divisions within *Polygala*; Saulmon (1971a, 1971b) followed Blake, and Miller (1971) was content to note that the *Decurrentes* of Chodat contained "clearly related species."

Recognition of infrageneric groups must always be subjective, and at times because of uncertain relationships elsewhere in a genus, one is tempted not to name even the more distinct aggregations. Since the time of Chodat, however, there has been general agreement as to the evolutionary homogeneity of the *Polygala* species with decurrent sepals. Although the features which unite the group are not of a magnitude to confirm the judgment of Rafinesque and Small that these species constitute a recognizably distinct genus, their structural similarities, supported by their common range on the Southeastern Coastal Plain and uncontradicted by the constancy of their chromosome numbers, seems justification for formal recognition at a lower level. Designation with the rank of series, as *Decurrentes* Chodat, is an appropriate means of inserting this group at a suitable level in the genus *Polygala*.

A total of 2,463 specimens from 12 herbaria was examined during this study. Lending institutions were: BUS, DUKE, F, FLAS, FSU, GA, MO, NCU, NSC, NY, PH, US. Distribution maps and specimen citations omit collections beyond those necessary to give indication of range.

MORPHOLOGY

HABIT. Plants of the series *Decurrentes* are all herbaceous, either erect or ascending, glabrous, and may appear succulent, particularly in the rosette stage. Their size varies from about 2.5-3 cm, a minimum height of *P. smallii*, to 11 dm, a maximum height of *P. cymosa*. The stems are round and smooth, or ridged. Most species may be either annual or biennial. *Polygala ramosa* appears to be consistently annual. *Polygala lutea* at least occasionally may be perennial, as was concluded by Holm (1929) following a three-year study. The biennial characteristic is readily revealed by the formation of a leafy rosette one year, then a stem with flowers the second year. No species exhibit a rhizome.

Reproduction is solely by seed. Since the flowers are small and the inflorescences often densely crowded, the number of seeds produced is high.

ROOTS. The root systems of the series vary from fibrous to tap-roots. *Polygala cymosa* has fibrous roots, while *P. nana* and *P. smallii* develop tap-roots. The rest of the species may have either, depending on the age of the plant and perhaps the influence of environment.

The root system customarily has a wintergreen-like odor, a frequent condition throughout the genus *Polygala*. This fragrance gives these plants the common name of "candy-weed" or "candy-root." All species have a strong or fairly strong scent except *P. cymosa*, which has little of this characteristic odor.

LEAVES. The species in this series show two major types of leaves, basal and cauline. A basal rosette is found in all species; however in *P. ramosa* and *P. balduinii* the leaves are usually withered by anthesis. Except for *P. cymosa*, the leaf shape is of an obovate-spatulate type which gradates upward to an elliptic-obovate shape. *Polygala cymosa* has long, broad, linear-lanceolate leaves in the basal rosette that abruptly change to widely spaced cauline leaves which are narrow and much smaller.

INFLORESCENCE. The inflorescences are of two recognizable types. One is the thick capitate raceme as found in *P. rugelii, P. lutea, P. nana,* and *P. smallii.* The other is a cymose panicle with racemose branches as in *P. cymosa, P. ramosa,* and *P. balduinii.* The branches may be dense as in *P. balduinii* var. *balduinii* or very loose as often occurs in *P. balduinii* var. *carteri.*

BRACTS. Each flower is subtended by one small and two minute bracts. In the species that have cymose inflorescences, the bracts are persistent. In the thick head-like racemes the bracts are deciduous, except in *P. nana* where they are usually deciduous but sometimes persistent.

FLOWERS. Flowers of the genus *Polygala are* zygomorphic and perfect. The calyx consists of a whorl of five free sepals. The two lateral sepals (wings) are large and petaloid and prominently project from the sides of the floral structure. These wings are orange, yellow, or yellowish in all species except *P. balduinii* in which they are white. The other three sepals are definitely sepaloid, the upper one being somewhat larger than the two lower ones.

The corolla is more specialized than the calyx. In this series it consists of three petals, two upper and one lower. The two upper petals are connate to the lower one but not to each other. One of the upper petals overlaps the other, forming an involute tube. The lower petal (keel) is distinctive, consisting of a blade which terminates in a hood-like flap (lamella) that partially encloses the reproductive organs. The outer surface of the lower petal bears a fimbriate or lobed extension (crest) that in size, shape and number of lobes is variable and is rather characteristic for each species. The corolla is deciduous upon maturation of the capsule.

The androecium consists of eight stamens in all species except in *P. nana* where there are usually six, although occasionally seven were observed. The general structure of the stamens is the same in all species. Each filament is adnate to the keel almost to the anther, the degree of adnation varying slightly with species. The anthers are all one-celled and when mature dehisce by a single oblique apical opening.

The gynoecium is characterized by a deciduous style which bifurcates in a vertical plane, with the ventral lobe curving distally upward. Both stylar lobes thus appear dorsal to the axis of the style. The distal stigma is tufted with long once-forked hairs. The proximal stigma is indument-free and is closer to the stylar axis. The ovary is two-celled and superior. Both cells are

functional, each containing one ovule borne on the distal portion of the septum.

FRUITS. All species have two-celled, wingless, thin-walled capsules. The locules are in the plane of the stylar lobes, each dehiscing by a single long loculicidal suture.

SEEDS. One seed is produced in each cell. Seeds in this series are lightly pubescent with the exception of *P. cymosa*, which is glabrous. A blunt rostrum may be present at the base of the seed. The size and shape of both the seed body and the aril are usually distinct for each species.

CYTOLOGICAL INVESTIGATION

Considering the size of the genus *Polygala*, there have been very few publications concerning chromosome studies. Only Lewis and Davis (1962) have published a *Polygala* cytology in the New World. They have also summarized the earlier work of Old World authors.

Lewis and Davis were impressed with the striking diversity of chromosome numbers encountered. They suggested a basic number of $x \pm 17$ for the section of the genus in which ser. *Decurrentes* occurs. They specifically reported *P. lutea*, *P. nana*, *P. ramosa*, and *P. rugelii* as having gametic counts of 34. These figures are in conflict with all counts obtained in the present study.

In all species of the series *Decurrentes* (excluding *P. smallii*, which was not counted) the gametic numbers here observed were 32. In the single species where a successful somatic count was obtained (*P. lutea*) the chromosomes numbered 64. Voucher specimens are recorded in Table 1. All chromosomes were small and without apparent differentiation.

TABLE I

CHROMOSOME NUMBERS OF POLYGALA SER. DECURRENTES

All counts were made from Florida materials. All vouchers are deposited in FLAS.

Taxon	*2n*	*n*	Source
P. cymosa		32	Clay Co., 3 mi. n. of Gold Head Branch State Park, *Smith & Myint 70.*
P. ramosa		32	Union Co., 3.8 mi. s. of Lake Butler, *Smith 94.*
P. balduinii			
var. *balduinii*		32	Lee Co., 7 mi. e. of Ft. Myers, *Smith 380.*
var. *carteri*		32	Dade Co., in glade adjacent to Long Pine Key, Everglades National Park, *Smith & Buchanan 103.*
P. rugelii		32	Pinellas Co., w. of 14th St., St. Petersburg, *Smith 160.*
P. lutea	64	32	Alachua Co., 6 mi. n.e. of Gainesville, *Smith* (10 Apr. 1961).
P. nana		32	Alachua Co., 6 mi. n.e. of Gainesville, *Smith* (10 Apr. 1961).

GEOGRAPHICAL DISTRIBUTION AND ECOLOGY

Representatives of the series *Decurrentes* are distributed along the Coastal Plain from New Jersey to Florida, westward to Texas, with *P. balduinii* var. *carteri* extending to Cuba. Their usual habitat is the moist to wet pine-barrens, pine-flatwoods, pine-palmetto associations, or open grassy savannas. *Polygala nana* and *P. smallii* also inhabit drier areas, the latter being found only in the dry sandy pine-palmetto areas of South Florida. Most of the species are able to withstand considerable competition, but *P. nana* and *P. smallii* are usually found in microhabitats of open areas void of other plants.

The over-all distribution of series *Decurrentes* indicates the southeastern United States as a point of origin. The lack of a fossil record makes impossible any certain knowledge of the age of the group, but the similar distribution of the various species strongly suggests an origin not too far in advance of the Pleistocene. The morphological diversity of the series is much greater than one might anticipate to develop in the relatively brief period since the Pleistocene.

During th Pleistocene epoch much of the area now occupied by members of the series *Decurrentes* was at least temporarily submersed (James, 1961). But islands and archipelagos isolated from the continental mass would clearly provide conditions under which divergent evolution and, ultimately, speciation could take place. Such opportunities may well have been responsible for some of the morphological diversity found in the *Decurrentes*.

Polygala lutea, P. nana, P. ramosa, P. cymosa and *P. balduinii* var. *balduinii* are relatively uniform throughout their ranges northward up the Coastal Plain and westward along the Gulf Coast. Their distribution either was not broken by Pleistocene flooding or, if broken, did not lead to morphological diversity. There is no reason to speculate that they have had any recent history more complicated than survival in the continental southeastern United States during Pleistocene flooding, followed by migration into the newly exposed Coastal Plain and Gulf Coast.

Polygala rugelii, limited in range to the Florida peninsula and yet adapted to the same habitats as some of the above more widely ranging species, suggests a different history. Its distribution may perhaps best be explained by the assumption that its pre-Pleistocene range was restricted to the area of the Florida peninsula and that the species survived only on the Pleistocene islands from which it had since spread.

The two remaining taxa suggest perhaps a third mode of origin. *Polygala balduinii* var. *carteri* and *P. smallii* show very close relationships to *P. balduinii* var. *balduinii* and *P. nana* respectively. Their morphological differences may result from Pleistocene isolation in a manner similar to that suggested for *P. rugelii*, but with the more widely distributed member of each pair surviving also on the mainland and since spreading into the

newly exposed peninsula. However, it seems at least equally probable that these two taxa have resulted from a post-Pleistocene isolation by adaptation to the special habitats of South Florida.

SYSTEMATIC TREATMENT

Series *Decurrentes* Chod., Mém. Soc. Phys. Genève 31 (2)[2] :125. 1893.
Pilostaxis Raf., New Fl. N. Am. 4:88. 1838.
Type species: *Polygala lutea* L. (selected by Rafinesque, 1838)

Annuals, biennials, occasionally perennials. Root system fibrous or taproot. Stem erect to ascending, single or several, smooth or ridged. Basal leaves spatulate (gramineous in *P. cymosa*), usually thick. Cauline leaves alternate, entire. Stipules absent. Inflorescence a capitate raceme or a cymose panicle. Flowers yellow, orange, or white to greenish-white. Sepals 5, decurrent on pedicel and on inflorescence axis; lateral sepals (wings) large, petaloid. Petals 3; lower petal (keel) crested, connate to adjacent upper petals. Stamens 6-8, with filaments adnate to lower petal. Anthers single-loculed, opening by apical pore. Ovary 2-loculed; stigma 2-lobed with distal stigmatic surface tufted. Seed ellipsoidal to subspherical, short-pilose (glabrous only in *P. cymosa*); aril present, sometimes scarious or reduced to a minute scale, or absent.

Key to Taxa of Series *Decurrentes*

A. Inflorescence a cymose panicle of dense or elongated racemes, more or less flat-topped; lower leaves spatulate and withered or nearly so when plant flowers, or gramineous and persisting.
  B. Corolla and wings of calyx bright yellow; pedicels greater than 1.0 mm long.
    C. Basal leaves linear-lanceolate to linear, forming a large persistent rosette; stem more than 4 dm tall. 1. *Polygala cymosa.*
    C. Basal leaves broadly spatulate, usually withering once plant flowers; stem less than 4 dm tall. 2. *Polygala ramosa.*
  B. Corolla yellowish, wings of calyx white to greenish-white; pedicels less than 1.2 mm long. 3. *Polygala balduinii.*
    D. Inflorescence of dense racemes; wings definitely white; seed less than 0.6 mm long; aril on seed usually 0.2 mm long, infrequently smaller. 3a. var. *balduinii.*
    D. Inflorescence of more or less elongated racemes; wings cream to greenish-white; seed more than 0.6 mm long; aril on seed a minute scale or absent. 3b. var. *carteri.*
A. Inflorescence a solitary dense head-like raceme; lower leaves spatulate, persisting.
  E. Racemes bright yellow to orange; lobes of keel less than 1.5 mm long.
    F. Inflorescence yellow (drying yellow); lobes of keel bifurcated, 1 mm long. 4. *Polygala rugelii.*
    F. Inflorescence orange (drying yellow); lobes of keel single or occasionally bifurcated, less than 0.7 mm long. 5. *Polygala lutea.*
  E. Racemes lemon-yellow, greenish-yellow, to green; lobes of keel greater than 1.5 mm long.
    G. Inflorescence lemon-yellow to greenish-yellow; wings elliptic, involute

at apex; seed 1.6 mm long or less. 6. *Polygala nana.*

G. Inflorescence yellow-green to greenish; wings oblong-lanceolate, not involute at apex; seed 1.9-2.3 mm long. 7. *Polygala smallii.*

1. POLYGALA CYMOSA Walter, Fl. Car. 179. 1788.

TYPE: UNITED STATES: SOUTH CAROLINA: Berkeley County, T. Walter (HOLOTYPE: not seen and presumably no longer extant; the bulk of the Walter herbarium is lost, the small collection in the British Museum (Blake, 1915) appearing to be but a fragmentary representation given John Fraser (1789)). Fig. 1.

Polygala corymbosa Michx., Fl. Bor. Am. **2**:54. 1803.
Polygala graminifolia Poir. *in* Lam., Encycl. **5**:500. 1804.
Polygala attenuata Nutt., Gen. **2**:90. 1818.
Polygala acutifolia Torr. & Gray, Fl. N. Am. **1**:128. 1838.
Polygala cymosa Walt. var. *graminifolia* (Poir.) Torr. & Gray, Fl. N. Am. **1**:670. 1840.
Pilostaxis cymosa (Walt.) Small, Man. S. E. Fl. 744. 1933.

Biennial, erect, 45-110 cm tall, usually without branching below the inflorescence, from well-developed fibrous roots. Basal leaves 3.5-14 cm long, 0.2-0.6 cm broad, linear-lanceolate to linear, thin and flat, forming a large, persistent rosette; cauline leaves abruptly smaller, gradating in size to the bracts of the inflorescence. Inflorescence a single terminal cymose panicle, with numerous (to 150) racemose branches. Bracts 1-1.5 mm long, persistent. Pedicels 1-2 mm long. Flowers vivid yellow, turning from pale yellow to dark green upon drying. Upper sepaloid sepal 1.5-1.8 mm long, ovate, sparsely ciliolate; two lower sepaloid sepals 1.1-1.2 mm long, lance-ovate; petaloid sepals (wings) 2-4 mm long, 1.4-1.6 mm broad, oval to oval-oblong, 3-nerved, the apical portion involute. Petals 2.5-2.8 mm long, connate only at base; crest with 2-3 entire or bifurcating lobes. Seed 0.7-0.9 mm long, 0.6-0.7 mm broad, glabrous, rugose, with a small rostrum; aril minute, unlobed.

Anthesis: April through August.

Habitat and distribution: Moist to wet acid soil of open boggy communities and marshlands, often with the rosette beneath 1-10 cm water; peninsular Florida from Lake Okeechobee, northward on the Coastal Plain to southern Delaware and westward to Mississippi.

Polygala cymosa, with its gramineous leaves, glabrous seeds, and scarcely odorous roots, is clearly a peripheral member of the series *Decurrentes*. It cannot, however, be seen to have closer relationships elsewhere in the genus.

Representative specimens:

UNITED STATES: ALABAMA: Baldwin Co.: Wet boggy meadow in pinelands, 1 mi. n. of Stapleton, *Webster & Wilbur 3524* (NSC, US). Mobile Co.: Wet ground, Spring Hill, *Graves 1016* (MO, US). DELAWARE: Sussex Co.: Ditches and meadows, Ellendale, *Canby s. n.* (NY). FLORIDA: Duval Co.: Pine barren swamps, near Jacksonville, *Curtiss 511* (F, GA, MO, PH). Highlands Co.: In shallow water, border of Lake Lucas, n.e. of Sebring, *Garrett 143* (FLAS). Holmes Co.: Grassy pine flatwoods, 2.5 mi. s.w. of Bonifay, *Ford 3553* (FLAS). Martin Co.: Wet roadside ditch on Fla. 76, *Smith & Buchanan 124* (FLAS). Osceola Co.: Moist open pine area, 3.5 mi. e. of St. Cloud, *Smith & Buchanan 95* (FLAS). Santa Rosa Co.: In grassland, edge of cypress swamp, 7 mi. s. of Bagdad, *Ford 4128* (FLAS).

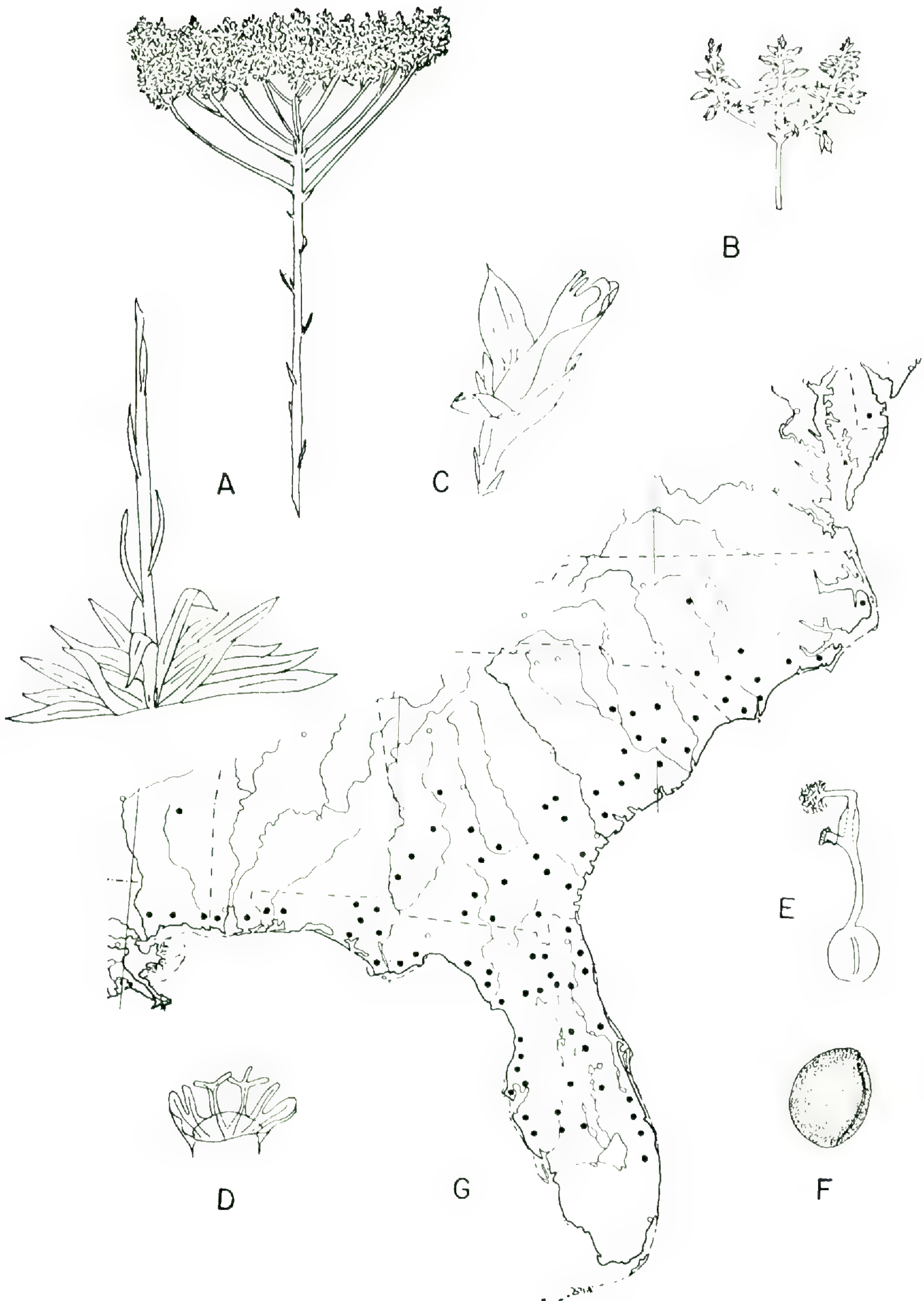


Figure 1. *Polygala cymosa*. A, habit × 1/5; B, 3 racemes at tip of peduncle × 2/3; C, single flower with one wing bent forward to expose petals × 8; D, crest on keel (lower petal) × 16; E, pistil × 10; F, seed × 15; G, distribution. (*Smith 70* [FLAS], Goldhead State Park, Fla.)

GEORGIA: Appling Co.: Dry bed of pool area in drainage way, 7.5 mi. e.s.e. of Baxley, *Duncan 11035* (GA, MO, NSC). Early Co.: Low undrained pinelands, 10 mi. s. of Blakely, *Hardin 141* (GA, NSC). Jenkins Co.: Wet sandy meadow, 0.5 mi. n.w. of Millen, *Pyron & McVaugh 929* (GA). McIntosh Co.: Low swampy soil near Darien, *Correll 5444* (DUKE, FSU, GA). Sumter Co.: Shallow pine-barren pond, w. of Leslie, *Harper 462* (F). MISSISSIPPI: Hancock Co.: Low pinelands, Necaise, *Sargent s. n.* (US). Jackson Co.: Ocean Springs, *Seymour 91-8-31* (F, FSU, MO, NCU). Newton Co.: *Tracy 5177* (MO). NORTH CAROLINA: Bladen Co.: In borrow pit, in standing water, 2.5 mi. e. of Elizabethtown, *Fox & Godfrey 2645* (NSC). Carteret Co.: In shallow acid pond, w. of Newport, *Whitford s. n.* (NSC). Dare Co.: Bog, 2 mi. s. of Manteo, *Radford 4639* (NCU). Wake Co.: Raleigh, *Hyams 682* (NSC). SOUTH CAROLINA: Berkeley Co.: Dried cypress pool, 5 mi. n. of Wanda, *Radford 5340* (NCU). Jasper Co.: Savannah, 2.1 mi. e. of Tillman, *Bell 3857* (FLAS). Marion Co.: Low pine savannah, s. of Britton Neck, *Bell 7871* (FSU, NCU). Sumter Co.: Cane savannah, *Stone 393* (NY, PH).

2. POLYGALA RAMOSA Elliott, Bot. S. Car. and Ga. 2:186. 1822.

TYPE: UNITED STATES: SOUTH CAROLINA: ? Charleston County, "ponds in the flat pine barrens," *S. Elliott* (HOLOTYPE: Stephen Elliott Herbarium, The Charleston Museum, Charleston, S. C., not seen; as photo NY!, US!). Fig. 2.

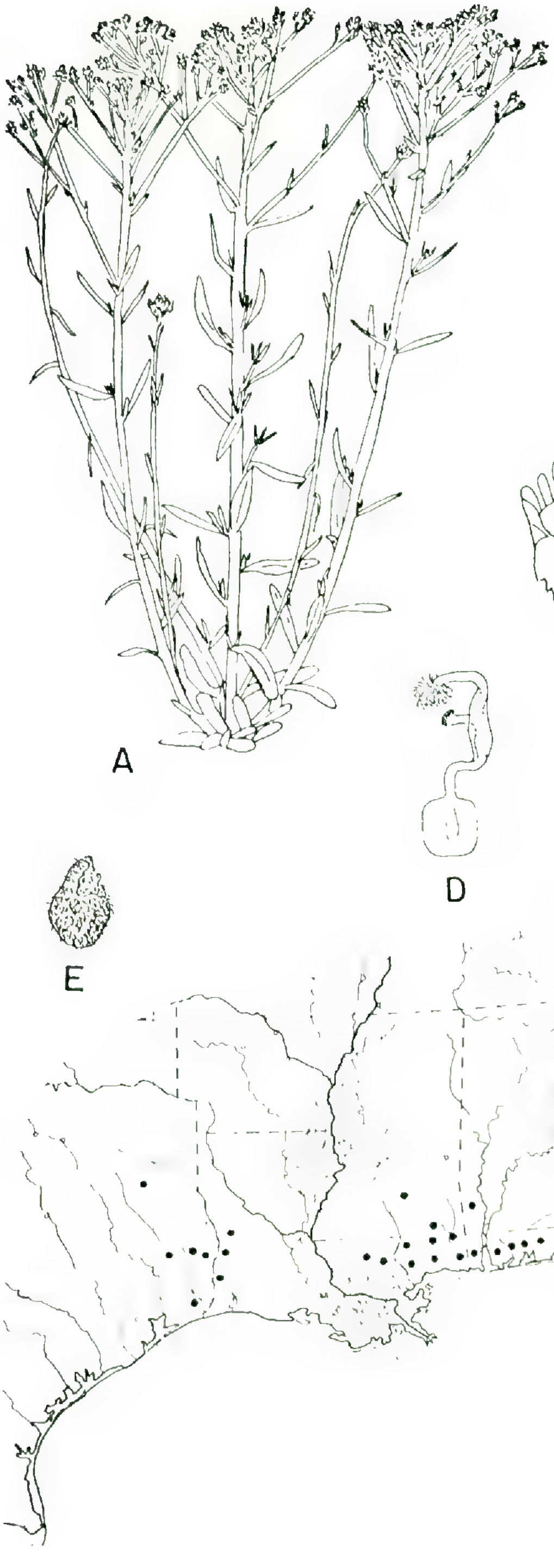
Polygala cymosa sensu Poir. *in* Lam., Encycl. 5:500. 1804; *non P. cymosa* Walt.
Polygala corymbosa Nutt., Gen. 2:89. 1818; *non P. corymbosa* Michx.
Polygala corymbosa sensu Torr. & Gray, Fl. N. Am. 1:128. 1838; *non P. corymbosa* Michx.
Polygala baldwinii var. *chlorogena* Torr. & Gray, Fl. N. Am. 1:129. 1838.
Pilostaxis ramosa (Ell.) Small, Man. S. E. Fl. 774. 1933.

Annual, erect, 10-38 cm tall, stems single or several, from fibrous roots. Basal leaves 3-7 cm long, 0.4-0.8 cm broad, spatulate, narrowing into petiole-like base, usually withering once plant flowers; cauline leaves spatulate-elliptic to linear. Inflorescence a cymose panicle, with few to many (to 110) racemose branches. Bracts 1.4-1.7 mm long, usually persistent. Pedicels 1.3-2.3 mm long. Flowers bright yellow, turning bright green or less frequently yellow-brown upon drying. Upper sepaloid sepal 1.2-1.6 mm long, wide lance-ovate; two lower sepaloid sepals 1.2-3 mm long, narrow lance-ovate; wings 2.5-3.5 mm long, 1.0-1.4 mm broad, obovate or elliptic-obovate, 3-nerved, involute at apex. Upper petals 2.5 mm long, ½ connate to lower petal (keel); keel 2.2 mm long; crest of simple or bifurcating lobes. Seed 0.6-0.7 mm long, 0.3-0.4 mm broad, with fine pubescence; aril minute to ¾ length of seed, 2-lobed.

Anthesis: April through October.

Habitat and distribution: Moist to wet, acid, moderately leached soil of low, open pine flatwoods and grassy roadside ditches; peninsular Florida, north on the Coastal Plain to Delaware, west to eastern Texas.

Polygala ramosa is closely related to *P. balduinii*. This similarity is obscured by the striking contrast between the yellow-flowered (green when dry) loosely branched inflorescence of *P. ramosa* and the white or near-white, more compact inflorescence of *P. balduinii*. Occasionally individuals occur that suggest hybridization; these have the flower color of *P. ramosa*,



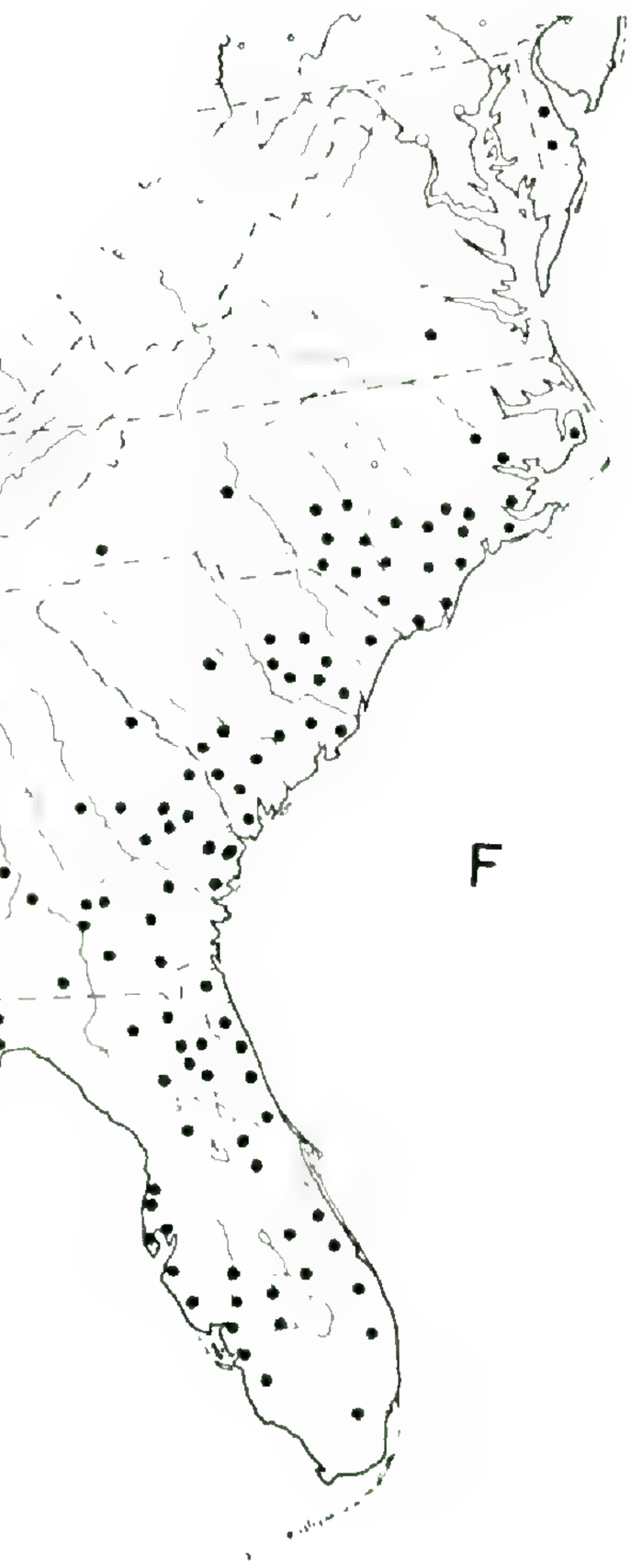


Figure 2. *Polygala ramosa.* A, habit × ⅓; B, single raceme × 5; C, crest on keel (lower petal) × 12; D, pistil × 8; E, seed × 15; F, distribution. (*Smith 94* [FLAS], Lake Butler, Fla.)

the compact inflorescences of *P. balduinii*, and pedicel lengths (1-2 mm) almost exactly intermediate. Such individuals have been called *P. balduinii* var. *chlorgena* Torr. & Gray (1838).

Representative specimens:

UNITED STATES: ALABAMA: Baldwin Co.: Low pine barrens, Magnolia Springs, *Schallert 758* (DUKE). Mobile Co.: In swamp, Spring Hill, *Bush 214* (MO, NY, US). Washington Co.: Low pineland, 4 mi. n. of Fruitdale, *Sargent s. n.* (GA, NSC). DELAWARE: Kent Co.: Felton, *Canby s. n.* (PH). Sussex Co.: Moist open sandy depression, e. of Ellendale, *Pennell 12869* (MO). FLORIDA: Alachua Co.: Low ground near Orange Heights, *Kea s. n.* (FLAS). Dade Co.: Low pineland back of Lemon City, *Small & Wilson s. n.* (F, NY). Escambia Co.: Dune area near Coast Guard station on Santa Rosa Island, *Ford 4484* (FLAS). Lee Co.: Moist sandy pineland, Pine Island, *Moldenke 942a* (NY). Osceola Co.: Shallowly flooded depression in cypress wooded area, Holopaw, *Howard 12965* (DUKE, FLAS, MO, NSC, NCU, NY, PH). Wakulla Co.: Sandy peat of ditch, 6 mi. n. of St. Marks Lighthouse, *Redfearn & Kral 2475* (DUKE, FSU, NY). GEORGIA: Baker Co.: Low open grassy meadow, 11 mi. n. of Newton, *Thorne 5032* (F, MO, NY). Charlton Co.: St. Mary's River swamp, below Trader's Hill, *Small s. n.* (F, NY). Chatham Co.: Pine barren near Half Moon Lake, *Eyles 6236* (GA). Laurens Co.: Moist sandy woodland, 10 mi. e. of Dublin, *Pyron & McVaugh 748* (GA). Richmond Co.: Pineland bog, Augusta, *Cuthbert s. n.* (NY). LOUISIANA: Calcasieu Parish: Vicinity of Lake Charles, *Allison 77* (US). St. Tammany Parish: Open pineland, 1 mi. n. of Abita Springs, *Pennell 4148* (NY, PH). Vernon Parish: Fairly wet grassy area, 2 mi. w. of Leander, *Webster & Wilbur 3242* (NSC, US). MISSISSIPPI: Covington Co.: Open pineland, 1.5 mi. s.e. of Mt. Olive, *Webster 3334* (NSC, US). George Co.: Abundant on black peat-loam of hillside bog, 1 mi. n.w. of Alabama line, *Kral 1298* (FSU). Pearl River Co.: Low pinelands, Picayune, *Sargent s. n.* (US). NORTH CAROLINA: Columbus Co.: Moist ditches and along seepage areas in large open savannah, 1.5 mi. n.e. of Nakina, *Wilbur 4204* (FSU, GA, NSC). Dare Co.: Along margin of swamp, n. of Wanchese, *Beal 1101* (NSC). Jones Co.: In savannah, 20 mi. s. of Kinston, *Wilbur 4093* (FSU, GA, NSC). Rowan Co.: Salisbury, *Porter & Heller s. n.* (NSC). SOUTH CAROLINA: Clarendon Co.: Grass-sedge bog or savannah, 3 mi. s.e. of Manning, *Godfrey & Tryon 912* (NY, US). Hampton Co.: Pine savannah, 3.1 mi. n.w. of Yemassee, *Ahles & Bell 15747* (NCU). Horry Co.: Open savannah near Myrtle Beach, *Correll 5277* (DUKE). Lexington Co.: Boggy swale, 5 mi. s. of Columbia, *Godfrey & Tryon 1265* (NY, US). TEXAS: Houston Co.: Sandy open bogs, Grapeland, *Palmer 12850* (MO, NY, US). Jasper Co.: Jasper, *Fisher 32123* (F). Jefferson Co.: Beaumont, *Hooks s. n.* (MO). VIRGINIA: Sussex Co.: Dry argillaceous field, n. of Littleton, *Fernald & Long 6263* (MO, US).

3. POLYGALA BALDUINII Nuttall, Gen. 2:90. 1818.

TYPE: UNITED STATES: FLORIDA: Nassau County, *W. Baldwin* (HOLOTYPE: Thomas Nuttall Herbarium, Academy of Natural Sciences, Philadelphia, not seen). Fig. 3.

Annual or biennial, stems 10-65 cm tall, rarely branched below inflorescence, single to several from thick fibrous or indefinite tap-root base. Basal leaves 0.5-2.5 cm long, 0.3-1.2 cm broad, obovate to spatulate, obtuse or rounded, crowded into irregular rosette, withered or nearly so when plant flowers; cauline leaves graduating from broad-eliptic to linear. Inflorescence a cymose panicle of numerous (to 40) racemose branches. Bracts 1.5-2.2 mm long, persistent. Pedicels 0.6-1.2 mm long. Flowers white or cream to greenish-white, drying from white to brownish-green. Upper sepaloid sepal 1.8-2.4 mm long, lance-ovate; two lower sepaloid sepals 1.6-2.2 mm long, lanceolate or linear-lanceolate; wings 2.8-4.8 mm long, 0.9-1.7 mm broad, 3-nerved, narrowing into a cusp-like apex. Petals 1.7-2.8 mm long, yellowish, connate at base only; crest with large simple lobes at lateral edges and

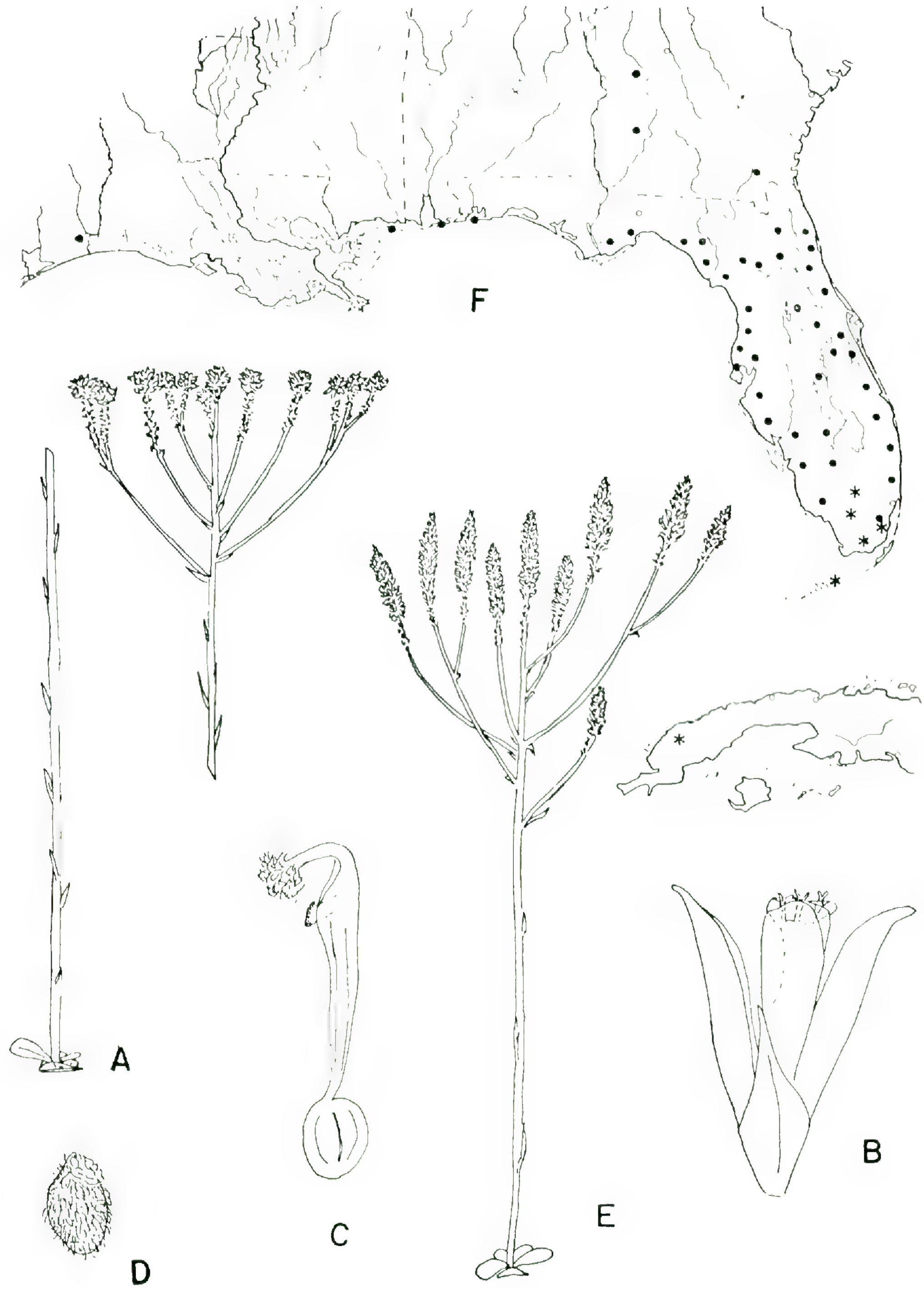


Figure 3. *Polygala balduinii*. A—D, var. *balduinii*: A, habit × ⅓; B, flower (adaxial view) showing crest on lower petal × 8; C, pistil × 10; D, seed × 15 (*Smith 122* [FLAS], Martin Co., Fla.). E, var. *carteri*: habit × ⅓ (*Smith 103* [FLAS], Everglades Nat. Park, Fla.). F, distribution: var. *balduinii* (dots), var. *carteri* (asters—S. Fla. and Cuba).

simple or bifurcating lobes in center. Seed 0.5-0.7 mm long, 0.4-0.5 mm broad, moderately pilose, with a small rostrum; aril scarious, of 2 appressed oval lobes, to 0.2 mm long, or a minute scale.

When Nuttall first proposed this name he Latinized the epithet as "*Balduini*"; this was purposeful as indicated by its repetition in his discussion. Torrey & Gray (1838) improperly modified the spelling to "*Baldwinii*" and have largely been followed by later authors. Article 73 of the International Code, however, compels the use of "*balduinii,*" reflecting corrections both in typography and orthography.

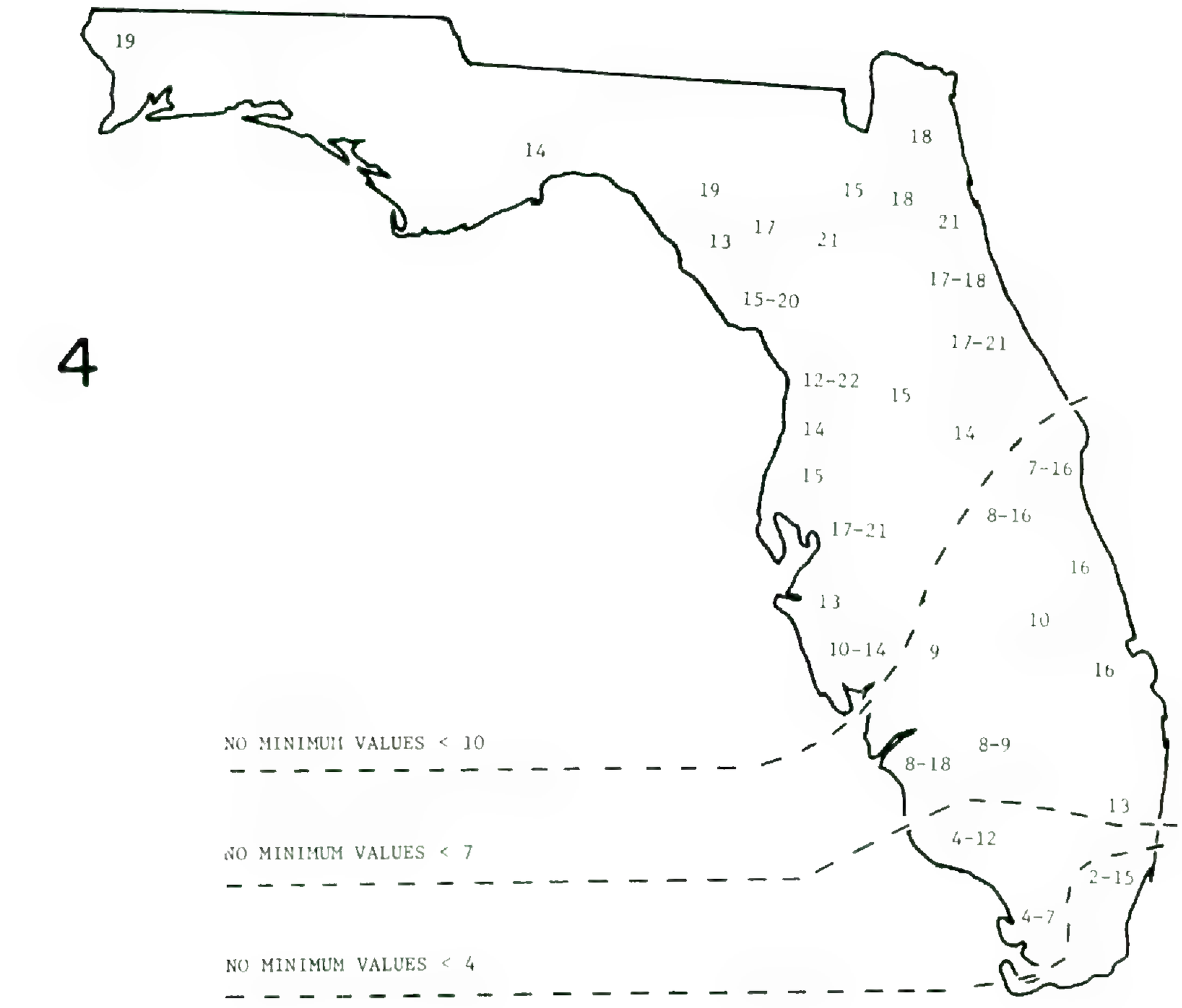
Small (1905) described from South Florida a new species of *Polygala* which he considered related to *P. balduinii.* He named it *P. carteri* in honor of his fellow collector, J. J. Carter. He first distinguished it from *P. balduinii* by the presence of elongate racemes and cuspidate wings, and later (1933) by an additional series of partially overlapping characters including flower color, size of capsule, and length of seed. A few of Small's criteria at first reading appear quite distinct, but they are not so apparent when applied to specimens from southern Florida. Blake (1924) recognized *P. carteri* without equivocation, but Miller (1971) thought it 'possibly conspecific" with *P. balduinii*, and Long & Lakela (1971) without comment reduced it to synonymy under that name.

Even cursory examination of *Polygala* in the field in South Florida reveals that in that area plants of *P. balduinii* s. l. are more variable than elsewhere in the range of the species. The flower color varies from white to cream to greenish-white; the racemose branches of the cymose panicle vary markedly in their degree of elongation; and a number of less conspicuous floral characters extend beyond the range of variability observed northward. Yet, as implied by the criteria cited by Small and by Blake, many individuals are not clearly assignable to either of the two species.

Wing size appears to be among the more discriminating characters. The wings of the South Florida plants are more uniform in size (3-4 mm long, 1.5-1.7 mm broad) with a short apical cusp (0.3-0.5 mm long), while *P. balduinii* elsewhere in its range is more varied (2.8-4.8 mm long, 0.9-1.4 mm broad) with a longer cusp (0.6-0.8 mm long).

Seed size definitely overlaps, but *P. "carteri"* tends to have larger seeds, approaching 1 mm in length. The aril, which is characteristically present on the seed elsewhere in the range of *P. balduinii,* is often absent in southern Florida.

A degree of additional objectiveness was provided by the use of a hybrid index, as popularized by Anderson (1949), for six characters: length of bract, wing width, length of upper sepal, length of cusp-like attenuation, length of seed, and presence or absence of aril. Equal weight was given each character (scaled from 0 to 4), with lowest values assigned to *P. "carteri"* and the highest to *P. balduinii* s. s. Data were obtained from 80 plants from 33 Florida counties. These have been plotted on a map of



Figures 4-5. Objective representation of variation within 80 plants of *Polygala balduinii* from 33 Florida counties, involving six characters. Fig. 4, a map of Florida showing low and high histogram values (low values = var. *carteri*, high values = var. *balduinii*); dashed lines indicate northern limits of low histogram values, restricting var. *carteri* morphotypes to southern end of the state, with var. *balduinii* occurring throughout. Figure 5, histogram, the abscissa being the possible totals obtainable by summation of values for the six measured characters, the ordinate being the number of individuals.

Florida (Fig. 4) and charted on a standard histogram (Fig. 5).

Measurements of the six utilized characters, when converted to histogram values and plotted on a map, show a striking restriction of plants with low values (characteristic of *P. "carteri"*) to the southern counties of Florida, with a perceptible increase in these minimum values as one moves northward in the state. Only within Dade County, the type locality for *P. carteri*, do values of 2 occur (with 0 the theoretical extreme for "pure" *P. "carteri"*). Adjacent Collier and Monroe counties have plants with values as low as 4, while it is necessary to travel almost to the center of the peninsula to obtain values in excess of 9. In contrast, plants with high histogram values (24 being the theoretical extreme for *P. balduinii* s. s.) occur throughout the state, and presumably throughout the southeastern Coastal Plain, reflecting the widespread distribution of individuals typical of the species.

The histogram (Fig. 5) incorporates values for all individuals measured. Its lack of bimodality supports observations in the field, that many individuals are intermediate in morphology. The definite regional tendency for South Florida plants to vary beyond the norms for the species does not seem sufficient for specific recognition. It is here proposed to give recognition to the differing individuals in South Florida only at the varietal level.

3a. POLYGALA BALDUINII var. BALDUINII

Polygala polycephala Balddw. ex Nutt., Gen. 2:90. 1818; as manuscript name.
Polygala "Baldwinii" sensu Torr. & Gray, Fl. N. Am. 1:128. 1838.
Pilostaxis "Baldwinii" (Nutt.) Small, Man. S. E. Fl. 774. 1933.

Racemes generally short and dense, to 3 cm long, 0.6-1 cm thick; bracts usually over 2 mm long. Flowers white, drying white to brownish. Upper sepaloid sepal usually over 2 mm long; wings 2.8-4.8 mm long, 0.9-1.4 mm broad, narrowing into lengthened cusp-like apex 0.6-0.8 mm long. Seed usually less than 0.6 mm long; aril 0.2 mm long, occasionally much smaller.

Anthesis: January through November.

Habitat and distribution: Moist to wet open pine flatwoods and moist grassy roadsides, often intermittently flooded; frequently sympatric with *P. ramosa*; peninsular Florida, northward to central Georgia and west (locally) to southern Mississippi and eastern Texas.

In gross appearance, *Polygala balduinii* var. *balduinii* is generally more robust than var. *carteri*, having taller stems and a larger and more conspicuous inflorescence. Specimens from a population in Lee County, Florida, were noted to have seeds lacking the characteristic pilose pubescence [*W. E. Liggett 1979a*, s.e. of Ft. Myers (FLAS)].

Representative specimens:

UNITED STATES: FLORIDA: Alachua Co.: In slash-longleaf pine flatwoods, between Gainesville and Newnan's Lake, *Ward 1281* (FLAS). Broward Co.: Low pinelands, Ft. Lauderdale, *Small & Wilson 1629* (NY). Collier Co.: Very moist grass-palmetto area, along U.S. 41, *Smith 372* (FLAS). Dade Co.: Humbugus Prairie, *Small, Mosier & Small*

6880 (NY, US). Duval Co.: Moist pine barrens, near Jacksonville, *Curtiss 504* (F, MO, NY, PH). Escambia Co.: Dune area near Coast Guard station on Santa Rosa Island, *Ford 4483* (FLAS). Franklin Co.: Low pine barrens, Apalachicola, *Saurman s. n.* (MO, NY, PH). Indian River Co.: Pinelands near Fellsmere, *Small 8883* (NY). Lake Co.: Swamp, vicinity of Eustis, *Nash 1179* (F, MO, NY, PH, US). Levy Co.: Peaty roadside ditch, 4 mi. e. of Cedar Key, *Kral 6989* (NCU, NY). Polk Co.: Open grass-sedge meadow, 9 mi. s.w. of Kissimmee, *Wilbur & Webster 2638* (NSC). Volusia Co.: Low flatwoods, Lake Helen, *Hood s. n.* (MO). GEORGIA: Baker Co.: Low open grassy meadow, 11 mi. n. of Newton, *Thorne 5049* (F, MO, NY, US). Charlton Co.: St. Mary's River swamp, below Trader's Hill, *Small s. n.* (F, NY, US). Sumter Co.: Moist shady pine-barrens, 2 mi. s.w. of Leslie, *Harper 1405* (F, MO, NY, US). MISSISSIPPI: Jackson Co.: Horn Island, Bay of Biloxi, *Tracy 1356* (F, MO, Y). TEXAS: Jefferson Co.: *Smith s. n.* (PH).

3b. POLYGALA BALDUINII var. **carteri** (Small) Smith & Ward, stat. nov.

Polygala carteri Small, N.Y. Bot. Gard. Bull. 3:426. 1905.
TYPE: UNITED STATES: FLORIDA: Dade County, "pinelands between Cutler and Black Point," *J. K. Small & J. J. Carter 813* (HOLOTYPE: NY!).
Pilostaxis carteri (Small) Small, Man. S. E. Fl. 774. 1933.

Racemes elongated and usually loose, 0.4-6 cm long, 0.4-1.3 cm thick; bracts usually less than 2 mm long. Flowers greenish-white to greenish-cream, drying as such with brownish tinge. Upper sepaloid sepal usually less than 2 mm long; wings 3-4 mm long, 1.5-1.7 mm broad, with apex short-tipped, 0.3-0.5 mm long. Seed usually 0.6-0.7 mm long; aril a minute scale, or absent.

Anthesis: March through August; December.

Habitat and distribution: Wet to seasonally very dry marl prairies, occasionally on calcareous waste areas or moist grassy roadsides; endemic to South Florida (Collier, Dade, and Monroe counties, including the Florida Keys), locally in western Cuba.

Polygala balduinii var. *carteri* is a less striking plant than var. *balduinii;* the plants are on average smaller, and the inflorescences are much more green and less conspicuous. Its northern limit is set more as a matter of arbitrary convenience than of objective judgment, for individuals with partial manifestation of the characteristics of the more extreme South Florida populations may be found, particularly in coastal areas (Brevard County), appreciably further north (Fig. 4).

Representative specimens:

CUBA: Pinar del Rio: In wet places, Remates, Cienaga La Tumba, *Ekman 11301* (US). UNITED STATES: FLORIDA: Collier Co.: In grassy glades, Copeland, *Brass 15403* (US); Deep Lake, *Scull s. n.* (FLAS). Dade Co.: Cut-over pineland, 6 mi. w. of Royal Palm Park, *Deam 60930* (DUKE); In tropical pineland on limestone, 5 mi. w. of Royal Palm Hammock, *O'Neill 7591* (F); Low pinelands, s. of Cutler, *Small & Carter 3065* (NY); Everglades near Cocoanut Grove, *Small & Wilson s. n.* (DUKE, FLAS); Glade, Key Biscayne, *Tatnall 842* (PH). Monroe Co.: Prairie at abandoned lumber camp, Pinecrest, *Arnold s. n.* (FLAS); Margin of pond along road to Watson Hammock, Big Pine Key, *Killip 44984* (FLAS).

4. POLYGALA RUGELII Shuttleworth ex Chapman. Bot. Gaz. 3:4. 1878.
TYPE: UNITED STATES: FLORIDA: Hillsborough County, "Tampa," *F. Rugel* s. n. (HOLOTYPE: not seen, presumably among the Alvan Wentworth Chapman collections of the Gray Herbarium; Rugel in 1845

collected near Tampa Bay, sending his materials to Robert Shuttleworth in Berne, Switzerland, who marketed large numbers of them to institutions and individuals in North America). Fig. 6.
Polygala reynoldsiae Chapm., Fl. S. U. S. 613. 1883.
Pilostaxis rugelii (Shuttlew. ex Chapm.) Small, Man. S. E. Fl. 774. 1933.

Annual or biennial, erect or ascending, 20-78 cm tall, with long branches from main axis, arising from definite tap-root. Basal leaves 3-6 cm long, 0.5-1.5 cm broad, spatulate, obtuse to rounded, succulent, drying rugose; cauline leaves gradating from oblanceolate to lanceolate. Inflorescence a head-like raceme, ovoid to thick cylindric, usually 2.5-3 cm long, 1.8-2.5 cm thick, occasionally elongated. Bracts 3.5-5 mm long, usually deciduous. Pedicels 2-2.5 mm long. Flowers bright yellow, drying pale yellow to dark greenish-brown. Sepaloid sepals 1.5 mm long, the upper deltoid-subulate, cuspidate; wings 4.5-8 mm long, 2-4 mm broad, oblong to oblong-elliptic, 7-nerved, the apex short-acuminate to apiculate. Petals 5.2-5.5 mm long; crest with bifurcating lobes 1 mm long. Seed 1.2-1.6 mm long, moderately pubescent; rostrum 0.2 mm long, rounded; aril membranous, to length of seed or longer.

Anthesis: April through November.

Habitat and distribution: Low moist open pinelands and well-drained palmetto-pine associations; endemic to peninsular Florida.

Polygala rugelii, although less common than *P. lutea* with which it is often found, when in flower is a conspicuous member of the Florida flora. Occasional populations [cf. *M. C. Reynolds s. n.,* St. Johns Co. (NY)] exhibit an elongation of the raceme. This anomaly was observed by Chapman (1883) who introduced the name *P. reynoldsiae* (in honor of the collector, Mary Reynolds, St. Augustine, Florida) for what he thought to be a new species. Such an elongation has also been observed in *P. lutea.*

Representative specimens:

UNITED STATES: FLORIDA: Alachua Co.: Openings in Serenoa repens –Lyonia lucida brush, 2.6 mi. w. of Island Grove, *Ward 1940* (FLAS, FSU). Brevard Co.: Flatwoods, w. of Sharpes, *Rhoads s. n.* (FLAS). Collier Co.: Open pine stand, 0.3 mi. s. of North Naples city limit, *Ward 1805* (FLAS). Dade Co.: Low pinelands, back of Lemon City, *Small & Wilson 1967* (NY). Flagler Co.: Low pinelands near Bunnell, *Wise s. n.* (FLAS). Hardee Co.: Pasture, e. of Zolfo Springs, *Cooley, Wood & Wilson 6092* (FSU, NY). Hernando Co.: Flatwoods pond margin, Weeki Wachee Springs, *Kral 7003* (FLAS, FSU, NY, US). Indian River Co.: Dry sandy area on Fellsmere road, *Smith & Myint 704* (FLAS). Lafayette Co.: Flatwoods, 3 mi. s. of Mayo, *West & Arnold s. n.* (FLAS). Lake Co.: Wet soil of ditch, near road to Astor Park, *Adams 606* (FSU). Lee Co.: Pineland, vicinity of Ft. Myers, *Standley 177* (NY, US). Levy Co.: Pine flatwoods, 1 mi. w. of Bronson, *Godfrey & Lindsey 56995* (FSU). Martin Co.: Bank of wet ditch, 0.4 mi. s. of St. Lucie Co. line, *Smith & Buchanan 126* (FLAS). Orange Co.: Open pine-palmetto area, 3.4 mi. n.w. of Brevard Co. line, *Smith & Buchanan 141* (FLAS). Pasco Co.: Sandy palmetto flatwoods, w. of Zephyrhills, *Hood 3501* (FLAS). Pinellas Co.: Moist open pine-palmetto area, St. Petersburg, *Smith 160* (FLAS). St. Lucie Co.: Open grassy field, 6.3 mi. s. of White City, *Hansen 928* (FLAS). Sarasota Co.: Sandy peat of depression in pine-saw palmetto flats, 3 mi. s. of Venice, *Kral 7481* (FLAS, NCU).

5. POLYGALA LUTEA Linnaeus, Sp. Pl. 705. 1753.

TYPE: UNITED STATES: NEW JERSEY: ? Gloucester County, *P. Kalm s.n.* (HOLOTYPE: 882.39 [Savage, 1945], Linnaean Herbarium, London, not seen; as microfiche!). Fig. 7.

Polygala lutea L. var. *elatior* Michx., Fl. Bor. Am. 2:54. 1803.

Polygala lutea L. var. *pauciflora* Raf., New Fl. N. Am. 4:90. 1838.

Polygala pseudosenega Bertol., Mem. Accad. Bologna 5:400. 1854: with exception of phrase, "Flores rosei."

Pilostaxis lutea (L.) Small, Man. S. E. Fl. 744. 1933.

Biennial or perennial, ascending and spreading or erect, 6-42 cm tall, with variations from a solitary unbranched axis to many stems branched or unbranched from a thick base; tap-root well developed in larger specimens, more fibrous in smaller plants. Basal leaves 1.5-5.8 cm long, 0.7-2 cm broad, spatulate to obovate, succulent with obscure venation, drying rugose, in an irregular rosette; cauline leaves obvate to oblanceolate. Inflorescence a head-like cylindric raceme, 8-33 mm long, 8-20 mm wide, rarely elongated (to 4 cm long). Bracts 2.5-3 mm long, deciduous. Pedicels 1.5-2.7 mm long. Flowers vivid orange to yellow-orange, usually turning a dull, pale yellow on drying. Sepaloid sepals 1.2-1.4 mm long, the upper ovate-acuminate, minutely ciliolate; wings 5.0-7.0 mm long, 2.7-3.6 mm broad, slightly oblique-elliptic, acuminate to short pointed, 5- to 6-nerved, partially involute at apex and slightly narrowed at base, minutely ciliolate. Petals 3.5-4.2 mm long, 2/3 connate; crest 0.5-0.7 mm long, of single or slightly bifurcated lobes. Seed 1.4-1.6 mm long, pilose; rostrum 0.3 mm long.

Anthesis: February through November.

Habitat and distribution: Typically acid soil with high water table, common in pine flatwoods, open grassy areas, or pine barrens; peninsular Florida north of Ft. Meyers, northward on the Coastal Plain to New Jersey and Long Island, New York, westward to eastern Louisiana.

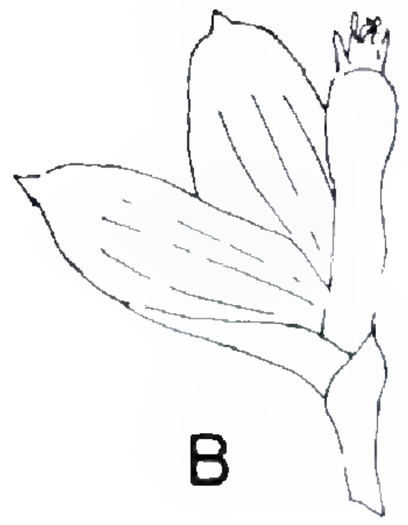
Polygala lutea is both the most widespread and the most abundant member of the series *Decurrentes*. Although the epithet was doubtless suggested by the color of the dried flowers, the living plants with their conspicuous orange inflorescences are a characteristic component of the acid flatwoods Coastal Plain flora. Hardin (1961) reported a color variation of lemon yellow for a single plant from Brunswick County, North Carolina.

This species is closely related to *P. nana*, *P. smallii*, and *P. rugelii*, and specimens are frequently encountered bearing one of these names. It is most definitely separated by the very small, largely non-bifurcating lobes of the crest, the otherwise distinctive orange flowers fading with maturity or with drying. Intermediates have not been encountered with *P. nana* or *P. smallii*. A single possible hybrid with *P. rugelii* revealed over 65% of the pollen grains as apparently non-functional.

Representative specimens:

Figure 6. *Polygala rugelii*. A, habit × ⅓; B, flower × 3; C, crest on keel (lower petal) × 12; D, pistil × 8; E, seed × 15; F, distribution, (*Smith 83* [FLAS], Trenton, Fla.)

A



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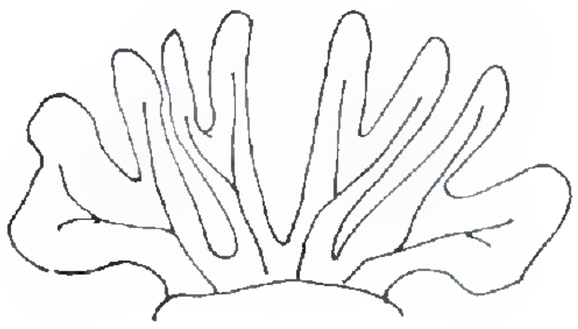

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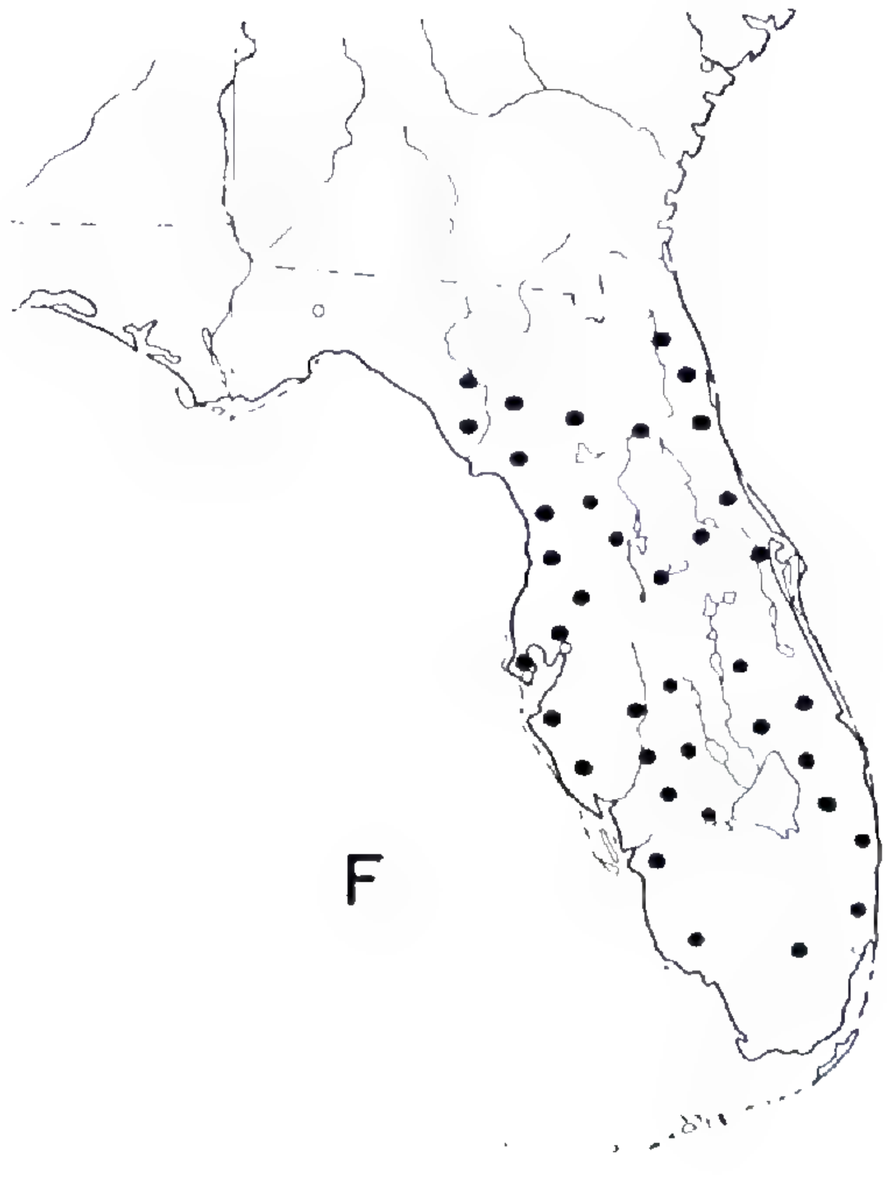

F

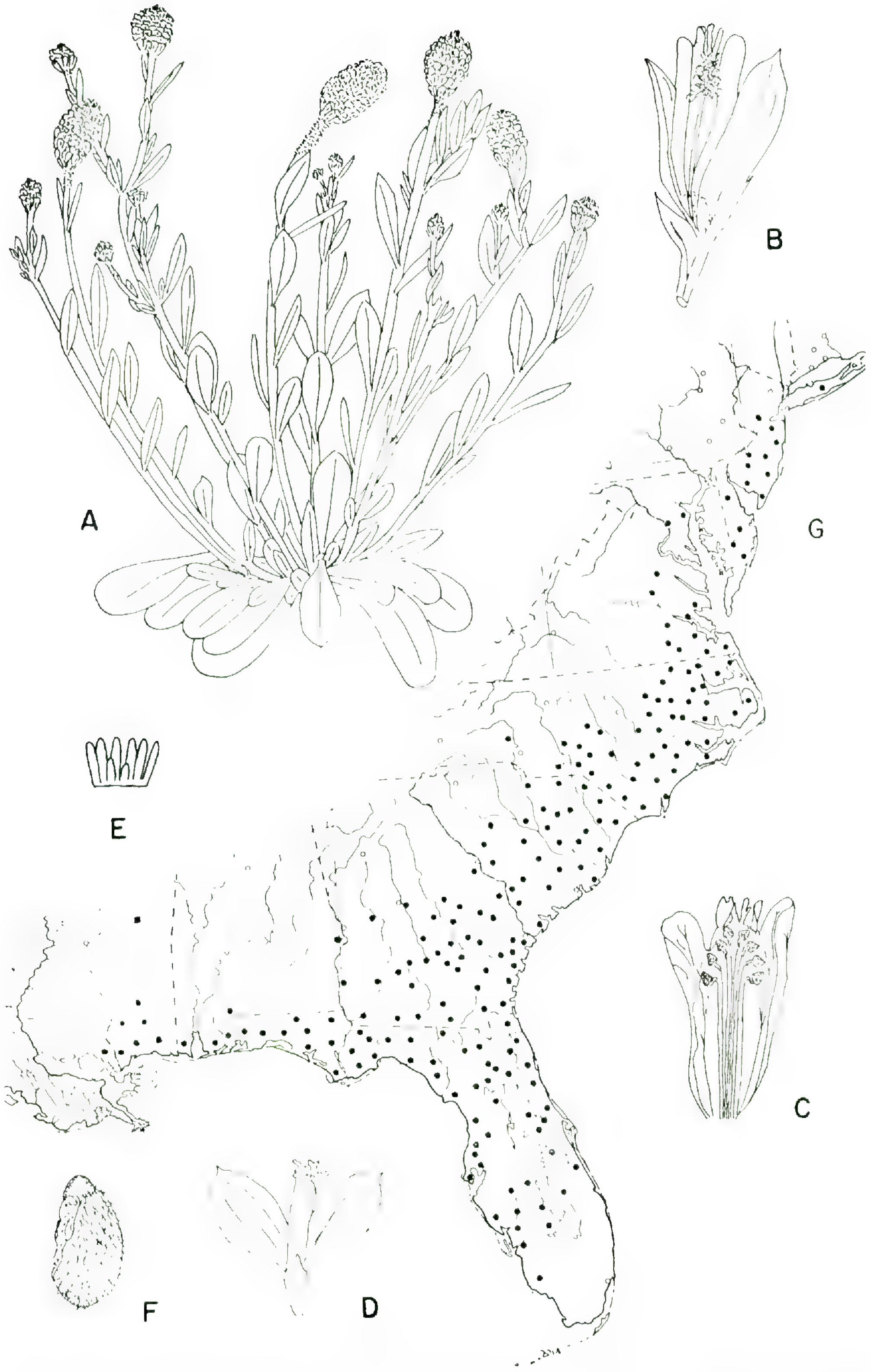

Figure 7. *Polygala lutea.* A, habit × 1/3; B, flower with upper petals separated, showing androecium and style, with hidden ovary indicated by shadowing × 4; C, corolla with upper petals widely separated showing androecium adnate to keel (lower petal) × 5; D, flower, with prominent petaloid sepals and inrolled 3-petaled corolla × 3; E, crest on keel × 12; F, seed × 15; G, distribution. (Drawn from fresh material, Alachua Co., Fla.)

UNITED STATES: ALABAMA: Baldwin Co.: Pine barrens, 5 mi. n. of Bay Minette, *LeClair s. n.* (NCU). Escambia Co.: Moist ground near spring, Escambia Exp. Forest, *Gaines 235* (NY). Mobile Co.: In swamps, Spring Hill, *Bush 221* (MO, NY). Russell Co.: Moist area on steep slopes on side of high ridge, 2 mi. w. of Phenix City, *Duncan 9641* (GA). DELAWARE: Kent Co.: In swamps near Harrington, *Gleason s. n.* (DUKE). Sussex Co.: Wet thick near Georgetown, *Britton 58* (NY). FLORIDA: Collier Co.: Sand flat near Immokalee, *Scull s. n.* (FLAS). Columbia Co.: Along roadside, 6.6 mi. s.e. of Suwannee River, *Smith & Myint 287* (FLAS). Flagler Co.: Flatwoods n. of Andalusia, *West & Arnold s. n.* (FLAS). Liberty Co.: Shallow pond in pineland, Bristol, *West & Arnold s. n.* (FLAS). Okeechobee Co.: Bayhead in longleaf pine, n. of Ft. Drum, *West s. n.* (FLAS). Putnam Co.: Low ground, Johnson, *Barnhart 2134* (NY). Santa Rosa Co.: Grassy pine flatwoods, 2 mi. s.e. of Milton, *Ford 4073* (FLAS). Union Co.: Flatwoods, 2 mi. s.w. of Raiford, *Murrill s. n.* (FLAS). GEORGIA: Brooks Co.: Moist savannah, 0.5 mi. n.e. of Barney, *Wilbur 3423* (GA, NSC). Bryan Co.: Sandy humus in thin pine woods, 7.8 mi. s.e. of Richmond Hill, *Moore & Lawrence 748* (FLAS, GA). Decatur Co.: Wet sandy soil, headwaters swamp of Willacoochee Creek, near Faceville, *Thorne, Muenscher & Smith 3023* (GA). Laurens Co.: Pine woods, s.w. of Cadwell, *Duncan 5000* (GA). Richmond Co.: Sandy low barrens, Augusta, *Cuthbert s. n.* (NY). LOUISIANA: St. Tammany Parish: Open pine woods, 5 mi. e. of Slidell, *Harris s. n.* (FSU). MARYLAND: Anne Arundel Co.: Sandy ditches, *Taylor s. n.* (F). Prince George Co.: Laurel, *Karr s. n.* (US). Wicomico Co.: Salisbury, *Carter s. n.* (PH). Worcester Co.: Along side of ditch, Snow Hill, *Vandegrilt 7253* (NY). MISSISSIPPI: Choctaw Co.: French Camp, *Clute 58* (NY). Forrest Co.: Hattiesburg, *Woodson & Anderson 1514* (MO). Hancock Co.: Wet pine barrens, Bay St. Louis, *Demaree 31930* (NCU). Jackson Co.: Ocean Springs, *Pollard 1168* (MO, NY, US). NEW JERSEY: Camden Co.: Swampy ground, Lindenwood, *Meredith s. n.* (MO). Cape May Co.: Low ground, Cape May, *Parker s. n.* (NY) Ocean Co.: Cedar swamp, 10 mi w. of Barnegat, *Gleason & Smith 172* (NY). NEW YORK: Suffolk Co.: In bog, headwaters of Browns Creek, Patchogue, *Muenscher & Curtis 6224* (PH, NY, US). NORTH CAROLINA: Brunswick Co.: Ditch bank, margin of shrub bog, 5 mi. n. of Southport, *Godfrey 49168* (NSC). Johnston Co.: Savannah-like meadow near Smithfield, *Garner s. n.* (DUKE). Lincoln Co.: Boggy sandy margins and adjacent woods, e. of U.S. 321, *Bell s. n.* (NCU). Pamlico Co.: Pine savannah, 1.5 mi. s. of Reelsboro, *Radford 35935* (NCU). Sampson Co.: Flat pine-oak woods, 1.1 mi. w.s.w. of Newton Grove, *Ables & Haesloop 29946* (NCU). SOUTH CAROLINA: Beaufort Co.: Pine savannah, e. side of S. C. 170, *Bell 3826* (NCU). Florence Co.: Low ditch by pine savannah, 1.8 mi. w.s.w. of Hyman, *Bell 7557* (NCU). Georgetown Co.: Grass-sedge bog or savannah, 12 mi. n. of Georgetown, *Godfrey & Tryon 48* (F, PH, US). Saluda Co.: Open dry sandy pineland, Monetta, *Norton 348* (US). VIRGINIA: Isle of Wight Co.: Near Franklin, *Heller 912* (F, MO). James City Co.: Sandy soil in sphagnum-magnolia swamp, w. of Williamsburg, *Grimes 3854* (NY). Nansemond Co.: Mossy depressions in sandy pine barrens, near Cox Landing, *Smith & Hodgson 964* (DUKE, F, FLAS, FSU, GA, MO, NSC, NCU, US). Prince George Co.: Sandy pineland, s.w. of New Bohemia, *Wherry & Pennell 14423* (DUKE, MO, PH).

6. POLYGALA NANA (Michaux) DeCandolle, Prodr. 1:328. 1824. Fig. 8.

Polygala lutea L. var *nana* Michx., Fl. Bor. Am. 2:54. 1803.
TYPE: UNITED STATES: ? SOUTH CAROLINA: "in partis udis Carolinae," *A. Michaux* (HOLOTYPE: in Herbarium Michaux, Museum National d'Histoire Naturelle, Paris, not seen).
Pilostaxis nana (Michx.) Raf., New Fl. N. Am. 4:89. 1838; combination indicated also under *Polygala*, but not made.
Pilostaxis hyemalis Raf., New Fl. N. Am. 4:89. 1938; combination indicated also under *Polygala*, but not made.
Polygala nana (Michx.) DC. var. *humillima* Chod., Mem. Soc. Phys. Geneve 31 $(2)^2$:200. 1893.

Annual or biennial, erect, 3-13 cm tall, stems unbranched, single to several from a definite tap-root, variable in height within same plant, often with one

short inflorescence in center of basal rosette. Basal leaves 1.1-5.5 cm long, 0.4-2 cm broad, spatulate, rounded, occasionally apiculate, narrowed at base, 3- to 5-nerved, succulent, drying rugose; cauline leaves very few if present, oblanceolate. Inflorescence a head-like cylindric raceme, 1-3.8 cm long, 1-1.7 cm thick, extending above the basal leaves. Bracts 4.5-6.5 mm long, usually deciduous, sometimes persistent. Pedicels less than 1 mm long. Flowers lemon yellow to greenish-yellow, drying to green or yellowish-green. Upper sepaloid sepal 0.4 mm long, subulate-lanceolate; lower sepaloid sepals 3-

Figure 8. *Polygala nana.* A, habit × ⅓; B, petaloid sepal, flattened × 7; C, flower with petaloid sepal turned down, exposing petals × 5; D, crest on keel (lower petal) × 6; E, pistil, with pollen adhering to distal stigma × 13; F, seed × 15; G, distribution. (Drawn from fresh material, Alachua Co., Fla.)

5.3 mm long, lanceolate; wings 5.5-7.5 mm long, 1.8-2.8 mm broad, elliptic, 3- to 5-nerved, long-acuminate to cuspidate, involute at apex, sparsely ciliolate. Two upper petals 3.5-4 mm long; keel 3.5-5 mm long; crest with bifurcating lobes 2 mm long. Seed 0.8-1.6 mm long, pilose; rostrum thick, 0.2-0.5 mm long; aril ⅓ to full length of seed.

Anthesis: February through June; October.

Habitat and distribution: Sandy well-leached soil, in dry palmetto-pine flatwoods, longleaf pine—turkey oak or scrub oak communities, or in moist grassy areas; peninsular Florida north of Ft. Myers, northward inland to western North Carolina, westward to eastern Texas.

Polygala nana apparently cannot stand much competition. It is often in small sandy clearings where the rosettes may spread. When found on embankments it is usually observed on the drier upper slopes, often with *P. lutea* occurring on the moister soil below. In South Florida (Lee and Collier counties) this species approaches the habit of *P. smallii,* with the inflorescences scarcely exceeding the leaves [cf. *P. C. Standley 12751* (US)], but even in these populations the distinctions enumerated under *P. smallii* remain valid.

Representative specimens:

UNITED STATES: ALABAMA: Baldwin Co.: Gateswood, *Tracy 8683* (F, MO, NY, US). Covington Co.: Upland pine woodland, between Lockhart and Wing, *Godfrey & Harrison 55403* (FSU). Houston Co.: Open grassy area at roadside, 9 mi. s.s.e. of Hartford, *Hardin & Duncan 14867* (GA). Mobile Co.: Pine flatwoods swamp on Dauphin Island, *Lund 298* (FSU). FLORIDA: Alachua Co.: Moist ditchbank along Fla. 26, in slash-longleaf pine flatwoods between Gainesville and Newnan's Lake, *Ward 1277* (FLAS). Duval Co.: Dry fertile soil, near Jacksonville, *Curtiss 518* (F, NY). Franklin Co.: In dry soil along U.S. 98, 4.3 mi. e. of Gulf-Franklin Co. line, *Ward & Smith 2612* (FLAS). Lee Co.: Among palmettos, vicinity of Ft. Myers, *Standley 51* (F, US). Martin Co.: On bank of wet ditch, 0.4 mi. s. of St. Lucie Co. line, along U.S. 1, *Smith & Buchanan 125* (FLAS). Santa Rosa Co.: Wet sand, lowland, at Yellow River, Rd. 87, s.e. of Milton, *Hood 1935* (FLAS). GEORGIA: Brooks Co.: Dry pinewoods, 10 mi. w. of Quitman, *Pyron & McVaugh 2177* (GA). Camden Co.: Low pineland, 5 mi. n. of St. Mary, *Blanton 6334* (US). Dade Co.: Sandy soil of abandoned field, summit of Lookout Mt. near Little River, *McVaugh 9025* (GA, MO). Seminole Co.: Pinelands on Sealy's Plantation, southern tip of county, *Thorne & Muenscher 2428* (GA). Washington Co.: Low pineland, 1.5 mi. s. of Tennile, *Duncan 17514* (GA). LOUISIANA: Calcasieu Parish: Moist sandy loam in longleaf pinewoods, DeQuincy, *Pennell 10239* (NY). Natchitoches Parish: Sandy barrens, Chopin, Palmer *7339* (PH, US). Quachita Parish: On moist sandy clay of oak-pine woods, 3 mi. s. Luna, *Kral 8758* (FSU). St. Tammany Parish: In pine woods, Mandeville, *Langlois s. n.* (F). MISSISSIPPI: Forrest Co.: Hattiesburg, *Woodson & Anderson 1569* (MO). Harrison Co.: Low ground in pinewoods, Long Beach, *Joor s. n.* (MO). Jackson Co.: Ocean Springs, *Skehan 59* (F, MO, NCU). Oktibbeha Co.: Starkville, *Tracy s. n.* (US). Pike Co.: McComb, *Earle s. n.* (NY, MO). NORTH CAROLINA: Buncombe Co.: Asheville, *Seymour 91-8-19-31* (DUKE). SOUTH CAROLINA: Union Co.: Lumbered sandhill with seepage area containing pocasin plants, 0.4 mi. s. of Boiling Springs Church, *Duke & Ables 2230* (NCU). TEXAS: Hardin Co.: Moist open pinewoods, Silsbee, *Palmer 9565* (MO, US). Newton Co.: Newton, *Fisher 3473* (F).

7. POLYGALA **smallii** Smith & Ward, nom, nov. Fig. 9.

Polygala arenicola Small, N. Y. Bot. Gard. Bull. 3:426. 1905, nom. illeg., non *P. arenicola* Gürke in Baum, Kunene Sambesi Expedition 273. 1903. TYPE: UNITED STATES: FLORIDA: Dade County, "pine-

lands between Cocoanut Grove and Cutler," *J. K. Small & J. J. Carter 1276* (HOLOTYPE: NY!).

Pilostaxis arenicola (Small) Small, Man. S. E. Fl. 773. 1933.

Biennial, erect, 2.0-7.5 cm tall, with 1 (usually) to 4 or more short unbranched or branched stems from well-developed tap-root. Basal leaves 1-4.2 cm long, 0.2-1.4 cm broad, oblanceolate to linear-oblanceolate, rarely near-spatulate, often absent, or in irregular, crowded rosette; cauline leaves similar. Inflorescence a head-like, cylindric raceme, 0.4-3 cm long, 0.5-1.8 cm thick, usually surpassed by the basal leaves. Bracts to 3.5 mm long, deciduous. Pedicels less than 1 mm long. Flowers green or greenish-yellow, drying the same color. Sepaloid sepals 0.5 mm long, the upper lanceolate or lance-ovate, the lower linear-lanceolate; wings 5-8 mm long, 2-3 mm broad, oblong-lanceolate, 3- to 5-nerved, long-acuminate, remotely ciliolate. Upper petals 4-4.5 mm long; keel 4 mm long; crest with bifurcating lobes to 3 mm long. Seed 1.9-2.3 mm long, pilose; rostrum large, rounded, 0.6-0.7 long; aril ½ to almost length of seed.

Anthesis: March through May.

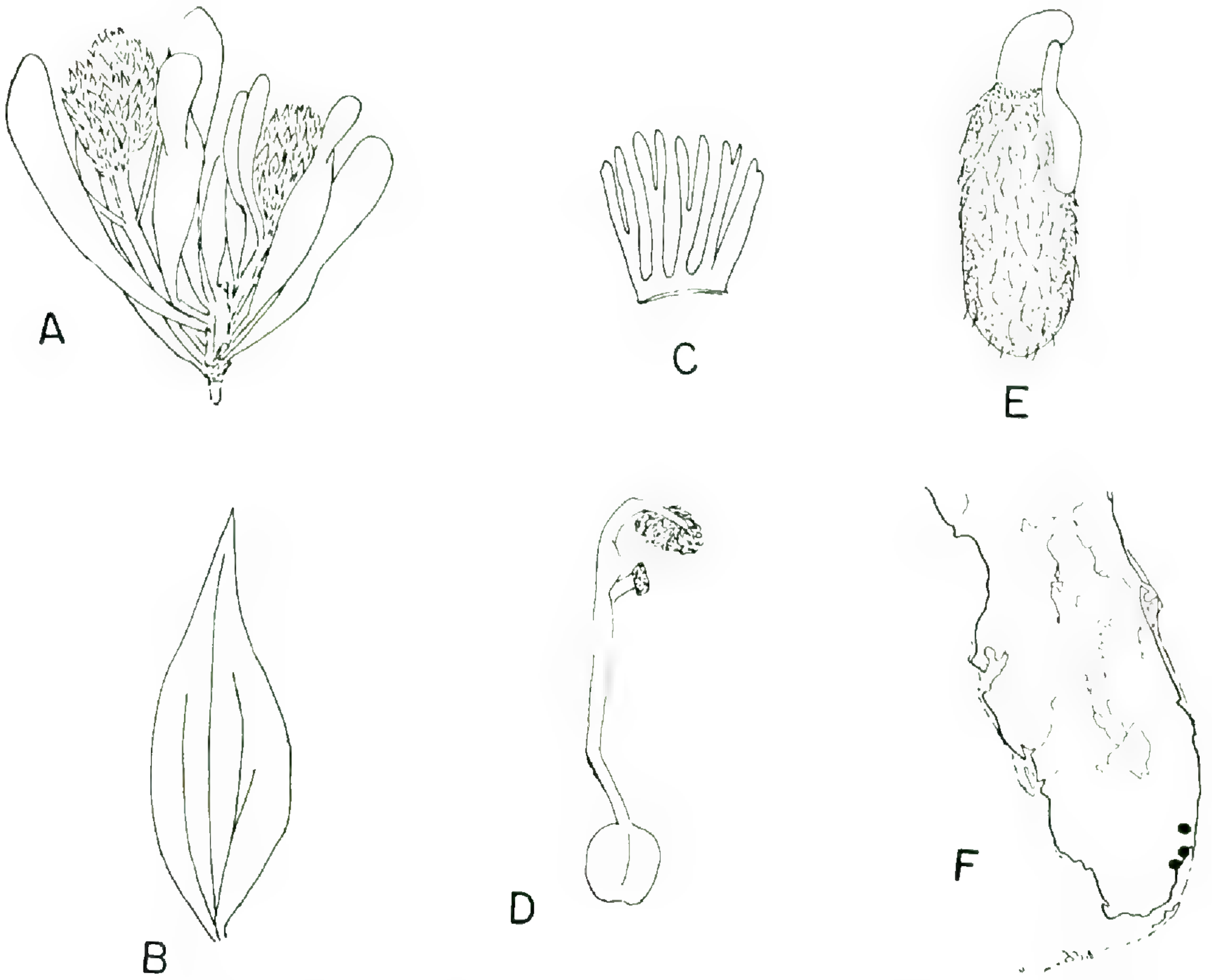

Figure 9. *Polygala smallii*. A, habit × ½; B, petaloid sepal, flattened × 7; C, crest on keel (lower petal) × 6; D, pistil × 12; E, seed × 15; F, distribution. (*Smith 755* [FLAS], Dade Co., Fla.)

Habitat and distribution: Sandy or calcareous rocky areas of the open grassy pinelands; endemic to South Florida (Broward and Dade counties).

Polygala smallii shares with *P. nana* the apparent inability to withstand competition and is characteristically found in small sandy openings in the dense herbaceous ground cover. It is clearly related to *P. nana* and has been relegated to that species by Blake (1924), Miller (1971), and Long & Lakela (1971). On close examination a number of consistent differences appear. The leaves of *P. smallii* are more lanceolate and much narrower, the wings are more lanceolate, the flowers are much greener at anthesis, and the length of the seeds is significantly greater. The most closely adjacent populations of the two species are separated by approximately 32 miles.

Small overlooked Gürke's detailed description in 1903 of a *Polygala* from southeastern Africa, under the name *P. arenicola,* rendering his later use of the epithet homonymous. Since Small's discovery of this species merits continued recognition, and since no conflict is created by its application to this most diminutive member of the series, it is here given the replacement name *Polygala smallii.*

Representative specimens:

UNITED STATES: FLORIDA: Broward Co.: In pinelands, Fort Lauderdale, *Small & Carter 1011* (NY). Dade Co.: Pinelands, Perrine, *Britton 149* (F, NY); Sandy pineland on corner of 26th Rd. and 3rd Ave. in Miami, *Eyles 8172* (NSC); Miami, *Garber s. n.* (FLAS, NY); Dry rocky soil, Miami, *Hood 72100* (FLAS); Miami, *Porter s. n.* (F); In dry open palmetto-pine flatwood, along Coral Reef Drive, South Miami, *Smith & Myint 755* (FLAS); Coconut Grove, *Peattie s. n.* (F); Pinelands about Arch Greek Prairie, *Small, Mosier & Small 6772* (NY, US); Pineland, Cutler, *Spink 106* (FLAS); *Woodbury s. n.* (BUS).

ACKNOWLEDGEMENTS

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REFERENCES

ANDERSON, E. 1949. Introgressive Hybridization. New York: John Wiley & Sons. 109 pp.

BLAKE, S. F. 1915. Some neglected names in Walter's Flora Caroliniana. Rhodora 17: 129-137.

_____. 1924. Polygalaceae. *In*: North American Flora 25: 305-370.

CHODAT, R. 1893. Monographia Polygalacearum. Mém. Soc. Phys. Hist. Nat. Genève 31(2): 120-140, 197-204.

_____. 1896. Polygala. *In*: A. Engler & K. Prantl, Die Natürlichen Pflanzenfamilien 3(4): 330-337.

DE CANDOLLE, A. P. 1824. *Polygaleae. In*: Prodromus Systematis Naturalis Regni Vegetabilis 1: 321-333.

FRASER, J. 1789. A short history of the *Agrostis cornucopiae.* London. 8 pp.

HARDIN, J. W. 1961. Color variation in *Polygala lutea.* Castanea 26: 102.

HOLM, T. 1929. Morphology of North American species of *Polygala.* Bot. Gas. 88: 167-185.

JAMES, C. W. 1961. Endemism in Florida. Brittonia 13: 225-244.

LEWIS, W. H. & S. A. DAVIS. 1962. Cytological observations of *Polygala* in eastern North America. Rhodora 64: 102-113.

LONG, R. W. & O. LAKELA. 1971. A Flora of Tropical Florida. Coral Gables: Univ. of Miami Press. 962 pp. [*Polygala*, 525-531.]

MILLER, N. G. 1971. The Polygalaceae of the Southeastern United States. J. Arnold Arbor. 52: 267-284.

SAULMON, J. G. 1971a. A revision of the Polygalaceae of the Southeastern United States [excluding Florida]. Ph.D. Dissertation, West Virginia Univ., Morgantown. 187 pp.

———. 1971b. The genus *Polygala* in the Southeastern United States. Proc. West Va. Acad. Sci. 43: 9-13.

SAVAGE, S. 1945. A Catalogue of the Linnaean Herbarium. London: Taylor & Francis, Ltd. 255 pp.

SMALL, J. K. 1933. Manual of the Southeastern Flora. New York. 1554 pp. [*Pilostaxis*, 773-774.]

TORREY, J. & A. GRAY. 1838. A Flora of North America. 1:126-129.

A NEW SPECIES OF PERITYLE (ASTERACEAE) FROM COAHUILA, MEXICO

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PERITYLE **carmenensis** Powell, sp. nov. Plantae perennes; caules 10-15 cm longi glabri vel minute sparseque pubescentes. Folia conferta opposita vel alterna 1-1.7 cm longa (petiolis inclusis), 0.5-0.9 cm lata glabra tenuia tripartita subcruciformia segmentis lobatis; petioli 5-8 mm longi. Capitula solitaria ca. 22-flora pedunculis tenuibus brevibus. Involucrum 4-5 mm altum anguste campanulatum, phyllariis 12-14. Flores radiati ca. 5 pistillati fertiles; tubus 2-2.5 mm longus glandulari-pubescens, ligula flava ca. 4 mm longa ca. 2 mm lata oblonga apice 3-dentata; flores disci corolla flava vel ad maturitatum purpurea 3.5-4.5 mm longa minute glandulosa fauce late cylindracea 1.8-2.2 mm longa. Rami styli ca. 2 mm longi tenues gradatim angustati apice acuti distaliter pubescentes adaxialiter planati. Achaenia compressa 2.8-3.3 mm longa anguste oblanceolata vel oblonga margine callosa utrinque brevipubescentes; pappus nullus. Chromosomatum numerus, $n = 17$ II.

TYPE: MEXICO: Coahuila. Maderas del Carmen, 102° 36' 30'' W, 0.5 mi N of El Dos on trail to El Tres, 2325 m, along stream, on overhanging cliff of igneous rock (rhyolite?) in thin soil, associated with *Pinus strobiformis, Pseudotsuga, Abies, Cornus, Physocarpus, Polypodium,* 7 Aug 1974, *A. Adamcewicz & T. Wendt 525* (Holotype, TEX; Isotypes, MWXU, and others to be distributed).

Known only from the type collection.

Perityle carmenensis is related to *P. castillonii* (sect. *Laphamia;* Powell, 1973) from which it is easily distinguished by radiate heads, leaf shape, and leaf glabrosity. The new yellow-rayed taxon belongs with an otherwise discoid group of three species with allopatric distributions in southeastern Arizona, west Texas, and southeastern Chihuahua. The related-species group also includes *P. dissecta* and *P. lemmoni.* Significantly, one atypical collection of *P. lemmoni* from Arizona (Powell, 1973) does have radiate heads, and this along with *P. carmenensis* from Coahuila suggests that the related-species group in question might have originated from a widespread radiate ancestor.

The specific epithet of *P. carmenensis* is taken after the Maderas del Carmen range of northern Coahuila to which it is probably restricted in distribution. The existence of the new species was brought to my attention by Tom Wendt who made the original collection and recognized it as prob-

SIDA 6(4): 311—312. 1976.

ably undescribed. I am grateful to M. C. Johnston for providing the Latin translation.

REFERENCES

POWELL, A. M. 1973. Taxonomy of *Perityle* section *Laphamia* (Compositae-Heleniеae-Peritylinae). Sida 5: 61-128.

A NEW SPECIES OF EUPHORBIA (SECTION CHAMAESYCE) FROM THE BAHAMAS

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In the recent upsurge of interest in the Bahama Flora, many new plant records have been reported (e.g. Gillis, Howard and Proctor, 1973; Correll, 1974; Hill, 1974), but few, if any, new species have come to light. Instead, as a result of more careful study, many of the old species of Britton and Millspaugh (1920) have been merged into more widespread species of the southeastern United States and the West Indies. In the present case, I wish to record the presence in the Bahamas of a previously undescribed species.

Despite the many collections from the islands to date, there are occasional sites that have not yet been botanized, and which may harbor narrow endemics. The environment of the new species is a rocky limestone coast, windswept and harsh. Under such conditions, a colonizer must quickly adapt in order to survive. This adaptation is reflected in a distinct new morphology and, presumably, also in a new genetic makeup. The plant described has tiny succulent leaves with revolute margins that enable it to survive in its hot, dry, sometimes salty environment. The tough stipules have become elaborated to sheathe the leaf base, and a woolly indument within the sheath further reduces water loss from the tender point of juncture of stem and leaf and protects tender buds. The branches are lax and flexuous, and the plant is rather appressed to the rocks, allowing its survival in the frequent gale winds in these islands. To survive a hurricane a plant must either be very flexible or very strong. Many woody plants in the Bahamas have very strong trunks, but have narrow flexuous branches more likely to twist than to snap.

Despite the apparently recent geological origin of the Bahamas, certain groups of colonizers have diverged sufficiently to be considered new species. The present case is such an example.

EUPHORBIA **longinsulicola** S. R. Hill, sp. nov., sectionis Chamaesycis; suffrutex perennis laxus 0.5-1 m altus, caule infime 6-9 mm crasso; rami glabri alterni, vaginis stipularibus persistentibus intra lanatis; laminae foliorum succulentae oppositae obovatae 3-7 mm longae 1.5-2 mm latae glabrae marginibus valde revolutis, apicibus rotundatis vel retusis, basibus breve angustatis; petioli 0.5-1 mm longi; cyathia olivacea obpyramidalia extus glabra 1.2-1.5 mm longa, pedunculis 1.0-1.2 mm longis, intra lanata; glandes 4 deltoideae 0.8-1 mm longae 0.3-0.5 mm latae exappendiculatae; flores

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SIDA 6(4): 313—316. 1976.

staminati plerumque 8, antheris 2 vel 3; flores pistillati brevi-exserti, glabri, stylis tribus integris; fructus maturi non vidi.

TYPE: BAHAMAS: Long Island, exposed seacoast at the end of the Buckleys Road, Deadman's Cay. Rooted in crevices of rock among wind-stunted shrubs. 1 July, 1974. *Steven R. Hill 2383* (Holotype, NY; Isotypes FTG, US, VT).

ADDITIONAL SPECIMEN EXAMINED: BAHAMAS: Long Island, exposed seacoast at Turtle Cove, between Clarence Town and Deadman's Cay, 31 May, 1972, *Steven R. Hill 832* (FTG, NY). Figure 1.

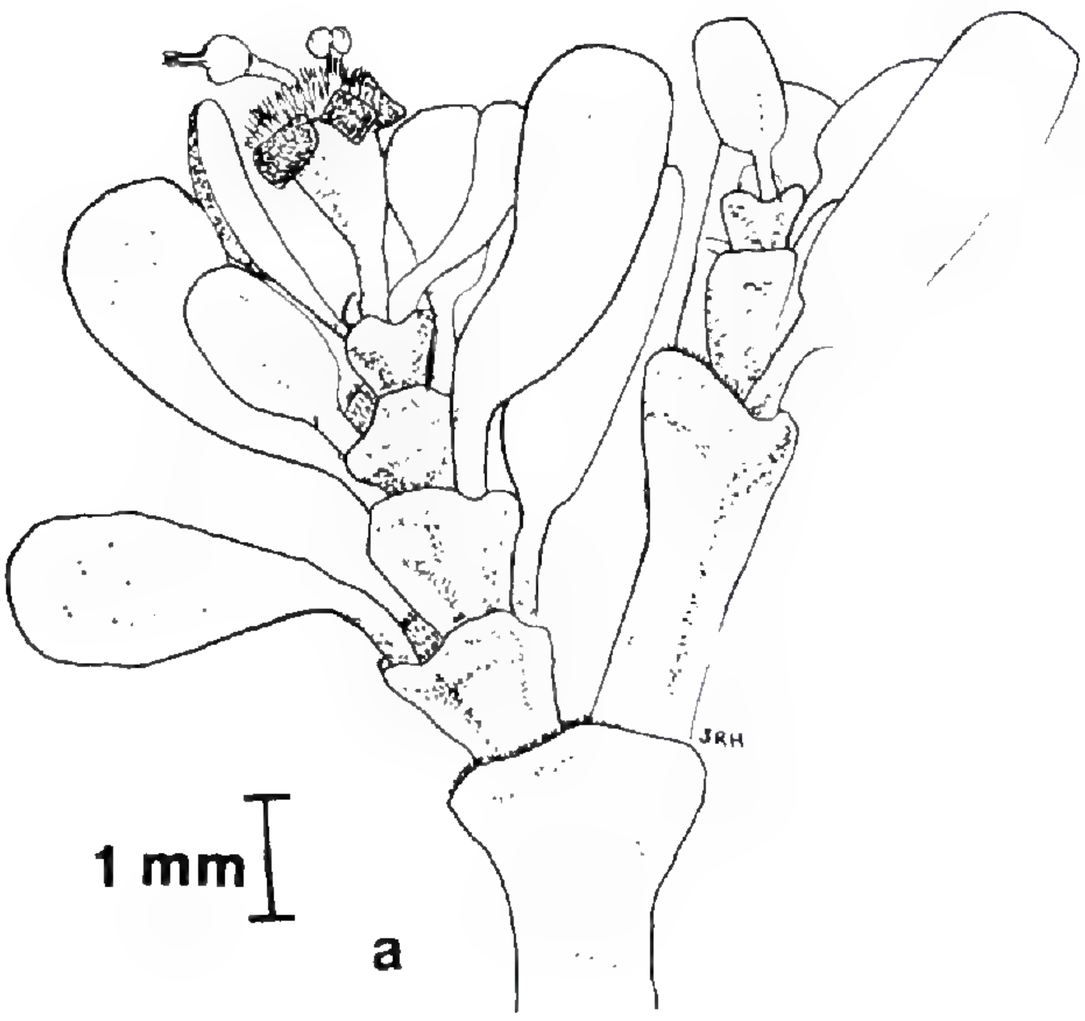
The new species is a perennial subshrub 0.5-1 meter tall, rather woody with flexuous lax branches. The branches are 6-9 mm thick at the base, alternate, glabrous, with persistent stipular sheaths that are woolly within giving the stem a jointed appearance. The leaves are opposite, obovate, rounded or usually retuse at the tip, 3-7 mm long and 1.5-2 mm wide. The bases of the glabrous and fleshy leaves are shortly attenuate, and the edges of the blade are strongly revolute, the edges being fused to the nerve beneath. The cyathia are solitary on branchlets, glabrous outside, in the axils of the leaves at the branchlet tips, obpyramidal, 1.2-1.5 mm long (measured from peduncle top to rim), olive-green with 4 dark brown (almost black) glands, without appendages; the deltoid glands are 0.8-1 mm wide (measured along the rim). The peduncle is 1.0-1.2 mm long. All cyathia counted had 8 staminate flowers. The pistillate flowers are short exserted, glabrous, and fewer in number than the staminate. The stamens bear two or three anthers. The third anther is, when present, either in reduced, non-functional form or apparently complete and functional. The plant was in full flower in early July, in contrast to the May specimen which was nearly sterile.

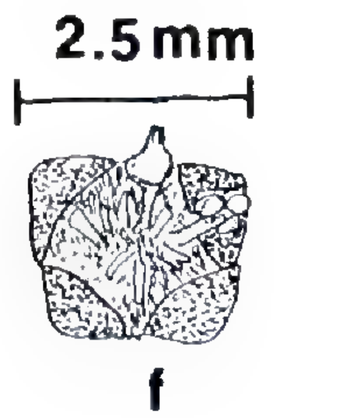
Euphorbia longinsulicola was found growing in an area of wind-swept limestone bedrock and stunted sea grape shrubs at a site previously uncollected. In more protected areas nearby the more common *Euphorbia mesembrianthemifolia* Jacq. grew. Field observations suggest that the species is restricted to a narrow strip of land exposed to wind and ocean influence along the coast from Turtle Cove to Deadman's Cay, a distance of about 15 km. The obovate, fleshy leaves and sprawling, shrubby habit seem to separate the taxon easily from the species of *Euphorbia* sect. *Chamaesyce* previously known from the Bahamas. It seems to be most clearly allied to another Bahamian endemic, *Euphorbia vaginulata* Griseb., but the latter species, which I examined in the field while on Inagua, has leaves that are rather brown and cinereous when fresh and which are significantly longer and narrower than those of the new species, and it has stipular sheaths that are prominently ciliate. In addition, *E. vaginulata* seems to prefer open sand or somewhat rocky areas, and has sparse, thin, erect branches. It is also not known to occur on Long Island.

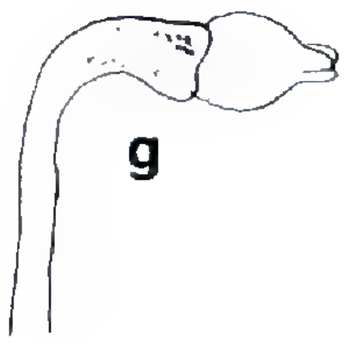
The species epithet indicates that it is an inhabitant of Long Island, the

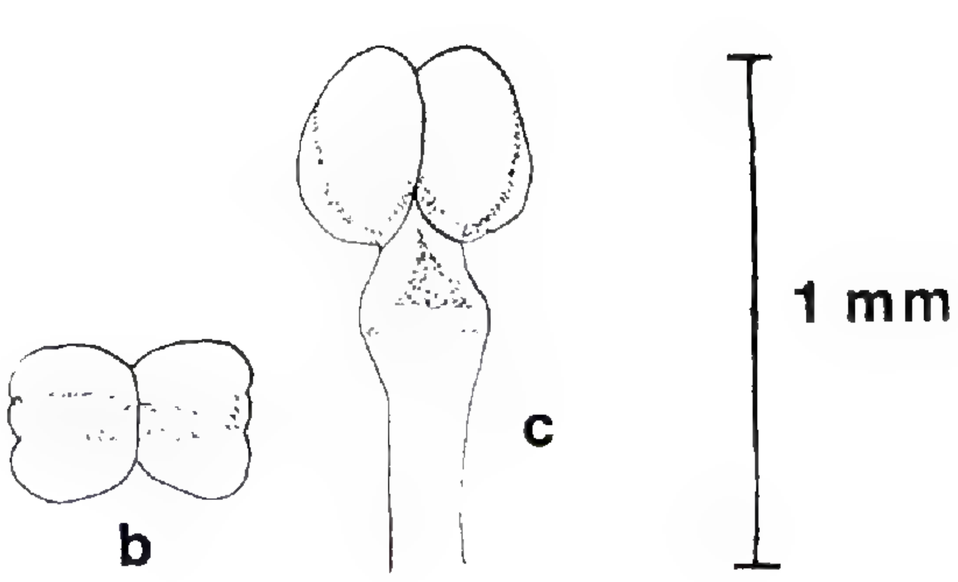
Bahamas.

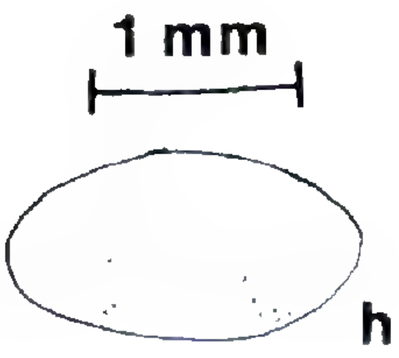
I would like to thank Dr. Derek Burch for his help in examining the plant and verifying its uniqueness (personal communication), and also Dr. Dono-











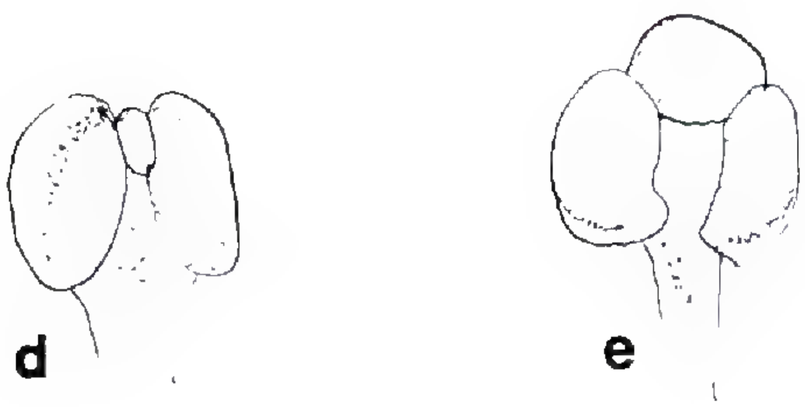


Figure 1. *Euphorbia longinsulicola* S. R. Hill a. stem axis and branchlet with cyathium. b-e portions of staminate flowers: b-c. typical staminate flower, top and lateral view; d. staminate flower with 2 normal and one abortive anther; e. staminate flower with three functional anthers. f. cyathium, top view. g. pistillate flower. h. cross-section of leaf, freehand, showing revolute-fused margin. All drawn from the holotype.

van Correll who has been very encouraging in this work. I would also like to thank Dr. Paul A. Fryxell for his encouragement and comments on the manuscript.

REFERENCES

BRITTON, N. L. & C. F. MILLSPAUGH. 1920. The Bahama Flora. Hafner Publishing Company, Inc. New York.

CORRELL, D. S. 1974. Flora of the Bahama Islands—new additions. Fairchild Trop. Gard. Bull. 29: 11-12; 15.

GILLIS, W. T., R. A. HOWARD, & G. R. PROCTOR. 1973. Additions to the Bahama flora since Britton and Millspaugh—I. Rhodora 75; 411-425.

HILL, S. R. 1974. Range extensions and new records for the Bahama flora. Rhodora 76: 471-477.

NEW GYPSOPHILIC SPECIES OF PSEUDOCLAPPIA AND SARTWELLIA (ASTERACEAE) FROM WEST TEXAS AND EASTERN CHIHUAHUA[1]

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The species described here provide additional examples of the remarkable effect of gypsum-edaphic endemism on plant speciation and they add to the list of new taxa discovered during the course of our study of gypsophilic vegetation of the Chihuahuan Desert region (Powell, 1972, etc.; Turner, 1972; etc.)

PSEUDOCLAPPIA **watsonii** Powell & Turner, sp. nov. Fig. 1.

Frutices (25-) 30-75 cm alti intricate ramosi ramis filo metalico similibus validis in parte superiore pedunculiformibus. Folia alterna carnosa subteretia 1.2-1.7 cm longa glabra superiora reducta bracteiformia. Capitula radiata solitaria pedunculis erectis ca. 4 cm longis; involucra late obconica 1.1-1.4 cm alta; bracteae inaequales 3-4-seriatae lineari-lanceolatae glabrae margine scariosae apice attenuatae (vel acutae); flores radiati 6-7(-11), ligulis flavis 1.0-1.3 cm longis, oblongo-ellipticis vel linearibus apice 1-2-incisuratis vel irregulariter fissis; disci flores ca. 25 corollis flavis 8.0-8.5 mm longis tubis ca. 2 mm longis faucibus cylindricis basem versus leviter angustatis 5.5-6.0 mm longis, lobis ca. 0.5 mm longis erectis vel leviter incurvatis; rami styli ca. 2 mm longi fere glabri lineares planati apicem versus leviter angustati apice truncate; antherae 3.5-4.0 mm longae. Achaenia matura nigra ca. 4 mm longa oblonga basem versus leviter angustata utrinque dense pubescentia pilis adpressis ca. 0.5 mm longis in transectione rhombea vel fere quadrata; setae pappi plures inaequales 8-10 mm longae subteretes vel complanatae stramineae antrorsus barbellatae. Chromosomatum numerus, $n =$ ca. 19.

TYPE: TEXAS. Hudspeth Co., Clay hills and arroyos, ca. 1 mi E. of Tommy's Town, 24 Aug 1974, *A. M. Powell 2792* (Holotype, SRSC; Isotypes, MO, TEX, US).

Additional specimen examined: TEXAS. Presidio Co., 53.8 road mi N of Candelaria, on slopes of a small hill along the primitive road to Chispa; Sierra Vieja foothills; with *Acacia, Agave, Yucca, Larrea, Condalia, Erioneuron* and *Xylorhiza*; rocky clay soil; only three plants observed; 21 May 1971, *T. Watson 630.*

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[1]Field work supported in part by NSF Grants GB-37674 and 29576X.

Figure 1. *Pseudoclappia watsonii* (*Powell 2792*); habit and achene.

Pseudoclappia watsonii is only the second species of the genus to be described, the other one being *P. arenaria*, a halophytic-gypsophile of southeastern New Mexico, north-central Mexico, and adjacent Texas. The new species is similar to *P. arenaria* except that most floral features and the heads are larger in *P. watsonii*. The two species are readily distinguished, however, by habit and habitat differences. *Pseudoclappia watsonii* is a strong, intricately branched, low shrub which apparently is restricted to dry, gypseous-clay soils; *P. arenaria*, while also a low shrub, evidently does not attain the size and branching habit of the other species and it occurs in more mesic saline-gypsum habitats such as along playa lakes, etc.

The new taxon was first collected by Dr. Tom Watson, former student of both authors, after whom we are pleased to name the species.

SARTWELLIA **gypsophila** Powell & Turner, sp. nov.

Suffrutices perennes glabri 35-80 cm alti erecti vel caulibus effusis. Folia opposita anguste linearia 7-12 cm longa 1.0-2.5 mm lata sessilia inferiora connato-vaginata. Capitulescentiae corymbiformes multiflorae apice planae. Capitula radiata 12-15 flora; involucra turbinata, bracteae 5 ellipticae acutae apice minute ciliato-laceratae; flores radiati saepe 5, ligulis flavis ovalibus vel oblongis vel ellipticis 1.5-1.8 mm longis 1.0-1.5 mm latis; flores disci corollis 2.0-2.5 mm longis tubis fere indistinctis, faucibus superius abrupte expansis lobis ca. 1 mm longis acutis maturis reflexis, styli rami ca. 0.5 mm longi vel breviores apice truncati penicillati. Achenia nigra 1.0-1.5 mm longa minute pubescentia; pappus coroniformis squamellis pluribus pro parte coalescentibus ca. 0.3 mm longis. Chromosomatum numerus, $n = 18$.

TYPE: MEXICO: Chihuahua. Jurassic gypsum near the lake road and ca. 5 mi NW of Lake Granero, ca. 16 mi from Morrión, 14 July 1973, *A. M. Powell 2536* (Holotype, SRSC; Isotype, TEX).

Known only from the type locality.

Sartwellia gypsophila was discovered at a locality where several other novel gypsophilic taxa have been found in the past few years, including members of *Argemone, Selinocarpus, Nerisyrenia*, and *Gaillardia*. The discovery of a new *Sartwellia* is surprising since the genus, containing only three species, was recently treated by the junior author (Turner, 1971); however, the gypsum area at the type locality was unexplored by botanists at that time which leads us to believe that yet other gypsophiles within this genus might remain undescribed from the area concerned.

Judging from pappus structure, leaf morphology, head size, and floral characters, *Sartwellia gypsophila* seems most closely related to the more northerly *S. flaveriae* of southern New Mexico and adjacent Texas although it also shares characters with the more southerly *S. puberula*. *Sartwellia gypsophila* is readily distinguished by its tall, suffruticose habit and selected floral characters. Other species of *Sartwellia* are annuals or short-lived perennial herbs, but all are restricted to gypsum substrates (Turner, 1971).

REFERENCES

POWELL, A. M 1972. A new species of *Argemone* (Papaveraceae) from Mexico. Southwest. Nat. 17: 106.

TURNER, B. L. 1971. Taxonomy of *Sartwellia* (Compositae—Helenieae). Sida 4: 265-273.

———. 1972. Two new species of *Isocoma* (Compositae—Astereae) from north central Mexico. Sida 5: 23-25.

ADDITIONS TO THE BAHAMA FLORA

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The following listing of further additions to the Bahama Flora is intended to supplement those of Correll (1974), Gillis (1975), Gillis, Howard, and Proctor (1973), and Hill (1974). The present study was undertaken as a project sponsored by the Fairchild Tropical Garden where I was employed as an assistant to Dr. Donovan Correll during the Spring and Summer of 1975. Dr. Correll's collections cited here with his permission were made by support from a Grant (No. DEB74-02135-A02) to him from the National Science Foundation.

In the listing, plant families are arranged in the order followed within the original *Bahama Flora* of Britton and Millspaugh (1920) for ease in comparison. Within each family, species are arranged alphabetically. Unless otherwise specified, the determinations were made by Dr. Correll or myself.

A full set of the cited specimens is housed at the Fairchild Tropical Garden Herbarium, Miami, Florida with duplicates sent to the New York Botanical Garden, Bronx, New York, the Field Museum Herbarium, Chicago, Illinois, and the Missouri Botanical Garden Herbarium, St. Louis, Missouri. They will serve as voucher specimens for the forthcoming revision of the *Bahama Flora* being undertaken at the Fairchild Tropical Garden.

I would especially like to thank Dr. Donovan S. Correll and Dr. John Popenoe for their support towards this project.

POACEAE

BRACHIARIA SUBQUADRIPARA (Trin.) Hitchc.: Andros, weedy-brushy area along edge of cultivated field near San Andros airport, January 29, 1974, *D. S. Correll & R. K. Godfrey 41312*; Berry Islands, in clumps on edge of coppice along road on Anderson Cay, Great Harbour Cay, October 16, 1974, *D. S. & H. B. Correll 43676*; North Eleuthera, in sandy soil of open coppice about Preachers Cave, January 12, 1974, *D. S. Correll 41176*; San Salvador, in moist coppice about 1 mile south of Finger Lakes Station, November 21, 1974, *D. S. Correll 43872*.

ERAGROSTIS PILOSA (L.) Beauv.: North Andros, in open field at Owens Town, February 2, 1974, *D. S. Correll & R. K. Godfrey 41519*.

NEYRAUDIA REYNAUDIANA (Kunth) Keng: South Bimini, in large clumps in depression on edge of coppice just north of airstrip, 4 m tall, April 18, 1974, *D. S. Correll 42155*. As far as we know this is the first report of the occurrence of this Asian species in the West Indies.

PANICUM COMMUTATUM Schult. (*P. joorii* Vasey): Grand Bahama, on

rich slope in partial shade in dense hammocky coppice in Fortune Hills area of Freeport, November 4, 1973, *D. S. Correll 40496*. This is an extension of this species from Cuba and Hispaniola.

PANICUM PORTORICENSE Desv. ex Hamilt.: North Eleuthera, in moist soil on edge of depression in palm-broadleaf savanna near intersection of road to Harbour Island ferry with Ridley Head Road, January 11, 1974, *D. S. Correll 41162*.

PASPALUM ARUNDINACEUM Poir.: Great Inagua, in large clumps 1.5 m tall, in depression, Horse Pond, northeast of Matthew Town, July 31, 1975, *D. S. Correll 45819*.

PASPALUM DILATATUM Poir.: Andros, in fields at Owens Town, February 2, 1974, *D. S. Correll & R. K. Godfrey 41520;* Grand Bahama, grassy soil bordering driveway at Jansel Courts, Freeport, August 17, 1974, *D. S. Correll & Robert Kral 42967*.

PASPALUM DISTACHYON Poit. ex Trin.: Great Abaco, forming mats in drying marl sink on northwest edge of Marsh Harbour, July 11, 1974, *D. S. Correll 42800*. This is an extension of this species from Cuba and Hispaniola.

PASPALUM FILIFORME Sw.: Little Exuma, in large clumps in rocky area about Williams Town, June 27, 1974, *D. S. & H. B. Correll 42485*. This is an extension of this species from Cuba and Hispaniola.

PASPALUM PLEOSTACHYUM Doell: Great Inagua, in open sandy soil along roadway between Matthew Town and Maroon Hill, August 19, 1975, *D. S. Correll 46032*; Long Island, roadside at the upper margin of the town salina, north side near clinic, Clarence Town, June 19, 1974, *S. R. Hill 2200*.

PASPALUM ROCANUM León in Britt.: Great Inagua, in disturbed saline flats about Morton Bahamas Limited salt pans, August 1, 1975, *D. S. Correll 45864*.

CYPERACEAE

CYPERUS SURINAMENSIS Rottb.: Andros, in field at Owens Town, February 2, 1974, *D. S. Correll and R. K. Godfrey 41518*; Grand Bahama, north end of Freeport airport, August 18, 1974, *D. S. Correll & Robert Kral 43014*.

DICHROMENA FLORIDENSIS Britt.: Andros, on pitted limestone in cut-over pineland just north of Love Hill, January 29, 1974, *D. S. Correll & R. K. Godfrey 41518*; Long Island, dooryard in moist soil, near Baptist Church, Deadman's Cay, July 1, 1974, *S. R. Hill 2392*; Grand Bahama, in and around freshwater ponds in pineland area in northcentral portion of island, about 2 miles from coast, November 6, 1973, *D. S. Correll 40568*.

RHYNCHOSPORA ELLIOTTII A. Dietr.: Grand Bahama, in water of freshwater ponds about 2 miles from coast, northcentral section of island, November 6, 1973, *D. S. Correll 40565*.

RHYNCHOSPORA INTERMIXTA C. Wr.: Grand Bahama, in water of pond in pineland, about 2 miles east of Freetown, November 6, 1973, *D. S. Correll 40585*.

BROMELIACEAE

CATOPSIS FLORIBUNDA (Brongn.) Sw.: Andros, uncommon local epiphyte, hardwood coppice along ridge 3.4 miles northwest of Love Hill, July 11, 1975, *S. R. Hill 3377.*

COMMELINACEAE

SETCREASEA PURPUREA B. K. Boom: Grand Bahama, in restricted area about 1 mile east of Freeport airport, along Queen's Highway, August 20, 1974, *D. S. Correll & Robert Kral 43059.*

ORCHIDACEAE

ONCIDIUM FLORIDANUM Ames: Gillis (1975) states that he has been unable to locate specimens of this taxon in the Bahamas. This record may serve to verify its presence. Andros, hardwood coppice along ridge, 3.4 miles northwest of Love Hill, July 11, 1975, *S. R. Hill 3374.* This species is often confused with *O. sphacelatum* Lindl.

CHENOPODIACEAE

CHENOPODIUM ALBUM L.: Andros, disturbed ground along farm road, 2 miles south of San Andros airport, July 13, 1975, *S. R. Hill 3445.*

NYMPHAEACEAE

NYMPHAEA ELEGANS Hook.: Great Abaco, in water of ponds in open pinelands along Forest Drive, about 1.5 miles northwest of Marsh Harbour, March 13, 1975, *D. S. Correll & F. G. Meyer 44603.*

BRASSICACEAE

CARDAMINE HIRSUTA L.: Grand Bahama, in rich soil in foundation plantings about Freeport airport, May 25, 1975, *D. S. Correll & John Popenoe 45446.*

LEGUMINOSAE

ADENANTHERA PAVONINA L.: New Providence, off JFK Road to airport, near Lake Cunningham, March 23, 1974, *D. S. & H. B. Correll & John Popenoe 41926.* This native of tropical Asia has become naturalized in various parts of America.

AESCHYNOMENE AMERICANA L. var. GLANDULOSA (Poir.) Rudd: North Andros, in field at Owens Town, February 2, 1974, *D. S. Correll & R. K. Godfrey 41514.* This species represents a genus new to the Bahamas.

CROTALARIA FALCATA Vahl ex DC.: Grand Bahama, in open fields about Freeport industrial area on way to harbor, plants 1.5 m tall, August 18, 1974, *D. S. Correll & Robert Kral 42972;* Great Abaco, in field along Great Abaco Highway, about 15 miles south of Marsh Harbour airport, July 7, 1974, *D. S. Correll & John Popenoe 42687.* These represent a new West Indian occurrence for this Old World species.

DESMODIUM CILIARE (Willd.) DC.: New Providence, in pineland near Mermaid's Pool, March 26, 1974, *D. S. & H. B. Correll 42028.*

MELILOTUS INDICUS (L.) All.: Eleuthera, in moist soil around lakes in dump area across from entrance to Cotton Bay Club, between Rock Sound and Green Castle, May 14, 1975, *D. S. Correll & S. R. Hill 45067.*

SESBANIA VESICARIA (Jacq.) Ell.: Andros, disturbed ground along farm road, 2 miles south of San Andros airport, July 13, 1975, *S. R. Hill 3457.*

EUPHORBIACEAE

ALEURITES MOLUCCANA (L.) Willd.: Eleuthera, large trees in coppice about an ancient dump, Half Sound area between Tarpum Bay and Rock Sound, May 18, 1975, *D. S. Correll & S. R. Hill 45270.* This native East Indian tree has become naturalized in the West Indies.

EUPHORBIA OPHTHALMICA Pers.: North Eleuthera, in sandy soil in open coppice near Preacher's Cave, January 12, 1974, *D. S. Correll 41192. Adams,* (1972, p. 431) includes the Bahamas in the area of distribution of this species. This collection, however, is the first we have seen of this species from the archipelago. I choose to accept *Chamaesyce* as a section of *Euphorbia.*

PHYLLANTHUS TENELLUS Roxb.: Grand Bahama, weed in border plantings at Jansel Courts, Freeport, August 17, 1974, *D. S. Correll & Robert Kral 42956.*

MALVACEAE

SIDA RHOMBIFOLIA L.: Andros, common in disturbed ground along farm road, 2 miles south of San Andros Airport, July 13, 1975, *S. R. Hill 3453.*

LYTHRACEAE

AMMANNIA COCCINEA Rottb.: Exuma, Hummingbird Cay, in low swale in dry meadow, January 19, 1971, *N. H. Nickerson & J. Dalton 3330.* Both common species of *Ammannia* in the Southeastern United States are now seen to occur also in the Bahamas. The second, *A. latifolia* L., is seen to be present in both the petaliferous and apetalous state, the former formerly being referred to the taxon *A. teres* Raf., now a synonym of *A. latifolia* L. (Graham, 1975).

ARALIACEAE

BRASSAIA ACTINOPHYLLA F. Muell.: Andros, an established escape, vicinity of main road and AUTEC road, Andros Town, July 12, 1975, *S. R. Hill 3413.* An abundance of young plants was found in the vicinity of a large, abundantly fruiting tree.

LOGANIACEAE

CYNOCTONUM SESSILIFOLIUM (Walt.) J. F. Gmel.: North Andros, on moist flat in opening in pineyard, Twin Lakes Region, January 29, 1974, *D. S.*

Correll 41295. Although Mrs. Northrop (1902, p. 57) reported this species as from Red Bays, Andros, Britton and Millspaugh disallowed it by referring her collection to *C. mitreola* (L.) Britt.

CONVOLVULACEAE

IPOMOEA FISTULOSA Mart. ex Choisy: Great Abaco, in disturbed soil among rubbish at edge of coppice-covered marsh in pineland area along Forest Drive, about 2 miles north of Marsh Harbour, July 11, 1974, *D. S. Correll 42809-A*; Little Exuma, on rocky open hillside at Ferry, December 13, 1973, *D. S. Correll 40961*; a suffruticose *Ipomoea*, escaped from cultivation, and now naturalized.

VERBENACEAE

VERBENA BONARIENSIS L.: Andros, disturbed ground along farm road, 2 miles south of San Andros Airport, July 13, 1975, *S. R. Hill 3435*. This collection represents a genus new to the Bahamas.

SOLANACEAE

LYCOPERSICON ESCULENTUM Mill. var. CERASIFORME (Dun.) A. Gray: New Providence, in waste area on edge of coppice, Yamacraw Beach area, March 23, 1974, *D. S. & H. B. Correll & John Popenoe 41914*.

LENTIBULARIACEAE

UTRICULARIA FIBROSA Walt.: North Andros, in fresh water of swamp near Behring Point, January 31, 1974, *D. S. Correll & R. K. Godfrey 41453*.

ULTRICULARIA PURPUREA Walt.: Grand Bahama, in water of canal just west of Pelican Lake, May 24, 1975, *D. S. Correll & John Popenoe 45422*; Great Abaco, floating on small pond on edge of marsh along Marsh Harbour-Treasure Cay road a little north of Marsh Harbour, July 5, 1975, *D. S. Correll & John Popenoe 42634*; North Andros, about 1 mile from Queen's Highway going west from Love Hill, in shallow water of swamp in pineland, February 1, 1974, *D. S. Correll & R. K. Godfrey 41475*; same location as preceding, July 11, 1975, *S. R. Hill 3365*.

ACANTHACEAE

BARLERIA CRISTATA L.: Andros, established around Andros Town airport, May 24, 1975, *S. R. Hill 2999*.

DYSCHORISTE OBLONGIFOLIA (Michx.) Ktze. var ANGUSTA (Gray) R. W. Long: Grand Bahama, several plants scattered over open pine savannah along Queen's Highway going east to North Riding Point, August 19, 1974, *D. S. Correll & Robert Kral 43030*.

JACOBINIA SPICIGERA (Schlecht.) Bailey: New Providence, in coppice behind beach near Delaport Point, March 24, 1974, *D. S. & H. B. Correll 41968*. This native of Mexico is now well established in a coppice on New Providence.

GOODENIACEAE

SCAEVOLA TACCADA (Gaertn.) Roxb.: Bimini, escaping along beach area on southeast coast of Cat Cay, July 12, 1975, *D. S. & H. B. Correll 45693*; Abaco, between airstrip and water on Walker's Cay, June 23, 1975, *D. S. Correll 45480*.

ASTERACEAE

BORRICHIA FRUTESCENS (L.) DC.: Grand Bahama, scattered over mud flats in marsh on edge of Pelican Lake, August 16, 1974, *D. S. Correll & Robert Kral 42902*. This species is maintained as distinct from *B. arborescens* (L.) DC. based especially on its reflexed, spine-tipped phyllaries.

CALYPTOCARPUS VIALIS Less.: Great Abaco, in lawns and vacant lots along waterfront at Marsh Harbour, July 8, 1974, *D. S. Correll & John Popenoe 42729*. This is an extension of this tropical American plant from Florida and Cuba.

CIRSIUM VITTATUM Small: Great Abaco, in open rocky soil, Treasure Cay, July 6, 1974, *D. S. Correll & John Popenoe 42666*; Great Abaco, in marshy area 1 mile north of Bail Sugar Mill, south of Marsh Harbour, July 7, 1974, *D. S. Correll & John Popenoe 42725*. *Cirsium horridulum* Michx. (*C. smallii* Britt.) and the above Floridian plant are maintained separately in Dr. Correll's forthcoming Flora of the Bahamas.

HELIANTHUS ARGOPHYLLUS T. & G.: Eleuthera, on open slopes around dump, Tan Bay, about 2 miles south of Palmetto Point, May 17, 1975, *D. S. Correll & S. R. Hill 45222*. This Texas endemic has also been seen under cultivation in George Town, Exuma.

TITHONIA DIVERSIFOLIA (Hemsl.) A. Gray: Andros, in coppice between Small Hope Bay and Hard Bargain, January 29, 1974, *D. S. Correll & R. K. Godfrey 41261*. This and the following species represent a genus new to the Bahamas. It is a native of Mexico and Central America that has become naturalized.

TITHONIA TUBAEFORMIS (Jacq.) Cass.: New Providence, forming colony among bushes and grasses along south side of runway at Nassau Airport, November 25, 1975, *D. S. Correll 46302*. Determined by Dr. B. L. Turner.

POLYPODIACEAE

NEPHROLEPIS RIVULARIS (Vahl) Mett. ex Krug.: Crooked Island, covering north facing cliffs at base of hill in open area just northeast of Landrail Point, February 19, 1975, *D. S. Correll 44404*.

REFERENCES

ADAMS, C. D. 1972. Flowering plants of Jamaica. University of the West Indies, Mona, Jamaica, 848 pp.

BRITTON, N. L. & C. F. MILLSPAUGH. 1920. The Bahama Flora. Hafner Publishing Company, Inc. New York.

CORRELL, D. S. 1974. Flora of the Bahama Islands—new additions. Fairchild Trop. Gard. Bull. 29: 11-12; 15.

GILLIS, W. T. 1975. Additions and corrections to the Bahama Flora—II. Sida 6: 52-62.
GILLIS, W. T., R. A. HOWARD, & G. R. PROCTOR. 1973. Additions to the Bahama flora since Britton and Millspaugh—I. Rhodora 75: 411-425.
GRAHAM, S. A. 1975. Taxonomy of the Lythraceae in the southeastern United States. Sida 6: 80-103.
HILL, S. R. 1974. Range extensions and new records for the Bahama flora. Rhodora 76: 471-477.
NORTHROP, A. R. 1902. Flora of New Providence and Andros. Mem. Torr. Bot. Club 12: 1-98.

POLLEN MORPHOLOGY OF DALEA SECTION THEODORA (LEGUMINOSAE—PSORALEAE)[1]

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ABSTRACT. The pollen morphology of *Dalea* section *Theodora* in the southwestern United States and Mexico has been studied. Four of the five species in section *Theodora* have a unique pollen type commonly referred to as "dogbone" with *Dalea mollis* possessing the typical prolate pollen type of the genus. A radial development of the pollen shape is evident from the prolate pollen type in the center of the geographic range of the section *Theodora* to the "dogbone" pollen type radiating outward to the north, east, and southeast. The pollen grains of *D. mollissima* represent the intermediate form between the prolate and the "dogbone" type.

After a preliminary study of the species of *Dalea* within the United States possessing an unusual pollen shape commonly referred to as "dogbone" pollen grains (Mahler, 1970), Barneby (pers. comm.) suggested that the pollen grains of section *Theodora* be examined. The section *Theodora*, as circumscribed by Barneby (pers. comm.), includes the following taxa: *Dalea mollis*, *D. mollissima*, *D. neomexicana* var. *neomexicana*, var. *longipila*, var. *megaladenia*, D. *simulatrix*, and *D. verna*.

MATERIALS AND METHODS. Pollen samples were taken from herbarium specimens and permanent acetolyzed pollen slides were prepared using the acetolysis method (Erdtman, 1960). Anthers were acetolyzed and the screening process was eliminated as the length of the "dogbone" grains, some over 140 um long, did not pass through the 50 um mesh screen except when oriented perpendicular to the screen. The pollen grains were mounted in glycerin on glass slides and sealed with paraffin. Herbarium specimens and the acetolyzed pollen slides are on deposit at their respective herbaria with duplicate slides at SMU (Table 1). The author is indebted to Rupert C. Barneby for access to his studies, additional materials, and suggestions regarding the manuscript. Gratitude is also extended to Blanche W. Meeson for the preparation of the pollen and photographs (MSM-2 Mini-SEM) and to Linda W. Laury for preparation of the plates.

RESULTS. The pollen grains of section *Theodora* are tricolpate, prolate to cylindrical (intermediate) to cylindrical with enlarged polar regions (dog-

[1] Descriptions of *Dalea* sect. *Theodora*, *D. verna*, *D. simulatrix*, *D. neomexicana* var. *megaladenia*, and the technical combination of *D. neomexicana* var. *longipila* will be published in a revision of genus *Dalea* by R. C. Barneby, currently in manuscript (Mem. N.Y. Bot. Gard. vol. 27).

SIDA 6(4): 328—331. 1976.

TABLE 1. Pollen and collection data of *Dalea* section *Theodora*.

Taxon	*Collector & No. or Date*	*Average Pollen Length Per Collection*
Dalea mollis	*Nelson 11135a (M)	47.6
	*Orcutt 1889 (MO)	49.1
	*Orcutt 1890 (MO)	51.0
	*Parker, et al 7796 (MO)	52.3
	*Gould, et al 4131 (MO)	53.1
	Pinkava, et al 103382 (SMU)	53.3
	*Wiegand, et al 3593 (MO)	54.1
	Mahler 6046 (SMU)	55.1
	Mahler 6074 (SMU)	56.4
	Mahler 5501b (SMU)	58.1
	*Wiegand, et al 3590 (MO)	58.9
	*Palmer 67 (10020) (MO)	59.3
	Mahler 6045 (SMU)	59.5
	Parker 7976 (SMU)	59.9
	Mahler 6030 (SMU)	66.3
	Clark 11194 (SMU)	67.1
Dalea mollissima	Brenckle 51136 (SMU)	85.2
	*Maguire, et al 4856 (MO)	89.8
	*Isely, et al 7228 (ISC)	91.5
	*Heller 15962 (MO)	103.2
	*Hitchcock 12362 (MO)	104.0
	*Rose 38341 (MO)	106.3
	*Kennedy, et al 1906 (MO)	107.7
	*Goodding 2237 (MO)	109.7
	*Munz 12605 (MO)	112.5
	Spahr 26489 (SMU)	116.1
	*Jones 1897 (MO)	118.5
	Clover 8243 (SMU)	136.4
Dalea neomexicana		
var. *neomexicana*	Mahler 6095 (SMU)	97.8
	Beasley, Finzel 865 (NY)	113.5
	Warnock, Hinckley BG 208 (SMU)	116.9
	*Isely 8386 (ISC)	120.1
	Correll 13734 (SMU)	123.6
	Grimes 317b (SMU)	123.6
	*Moore, Steyermark 3270 (MO)	125.7
	Grimes 317a (SMU)	129.4
	*Jones 26156 (MO)	130.0
	Thieret 30981 (SMU)	142.9
var. *longipila*	Mahler 5681 (SMU)	142.8
var. *megaladenia*	Ripley, Barneby 14207 (NY)	141.8
Dalea verna	Mahler 5746 (SMU)	125.4

* Previously reported by Mahler (1970).

bone-shaped) and 47-142 um in polar length (Fig. 1). The average pollen grain length per species is plotted in Figure 1, using horizontal bars. The average pollen grain polar length is relative as the number of collections per taxon differs because of the availability of suitable flowering material: *Dalea mollis*—56 um; *D. mollissima*—106 um; *D. neomexicana* var. *neomexicana*—122 um, var. *longipila*—143 um, var. *megaladenia*—142 um; *D. verna*—125 um (Table 1). *Dalea simulatrix* possesses long "dogbone" pollen grains that are easily observed with a dissecting microscope but measure-

ments of acetolyzed pollen are unavailable (Fig. 2).

The locations of the collections used in this study are plotted in Figure 1 with *Dalea mollis* possessing the prolate and shortest grains. This taxon is correctly delimited in the preliminary study (Mahler, 1970). However, *Dalea mollissima* extends northward into southern Nevada according to Barneby (pers. comm.) with *D. neomexicana* var. *neomexicana* extending westward only as far as Cochise County, Arizona.

DISCUSSION. The tricolpate pollen grains of section *Theodora* are prolate (*Dalea mollis*), cylindrical (*D. mollissima* in part), or cylindrical with enlarged polar regions (dogbone-shaped: *D. mollissima, D. neomexicana, D. simulatrix,* and *D. verna*). The pollen of *Dalea mollissima* ranges in pollen length from an average per sample of 85 to 136 um and is thus, intermediate in both shape and length between *D. mollis* and the other taxa of section *Theodora*. The development of the pollen shape appears to be radial from the prolate pollen type (assumed to be the primitive type) in the center

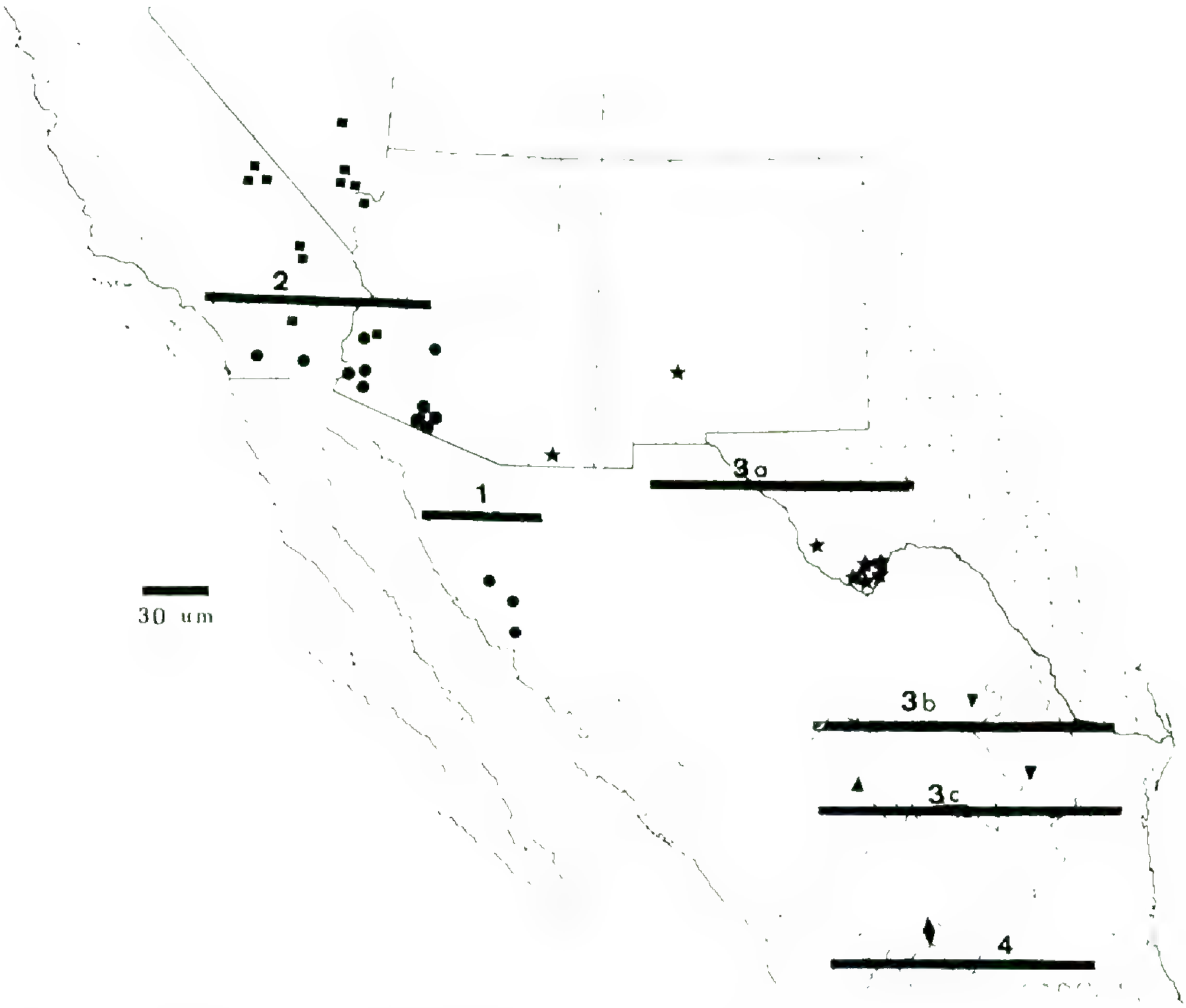

Figure 1. Distribution of collections of *Dalea* section *Theodora*. The average pollen polar length per species or variety is indicated by the horizontal bars (um). 1. *Dalea mollis* (circles); 2. *D. mollissima* (squares); 3a. *D. neomexicana* var. *neomexicana* (stars), 3b. var. *longipila* (triangle points down), 3c. var. *megaladenia* (triangle points up); 4. *D. verna* (diamonds).

of the geographic range with the other taxa possessing the "dogbone" type at the periphery of the range of section *Theodora*.

In summary, *Dalea* section *Theodora* may be considered as the "dogbone" pollen grain group that includes *D. mollis* with the typical prolate pollen type characteristic of the genus.

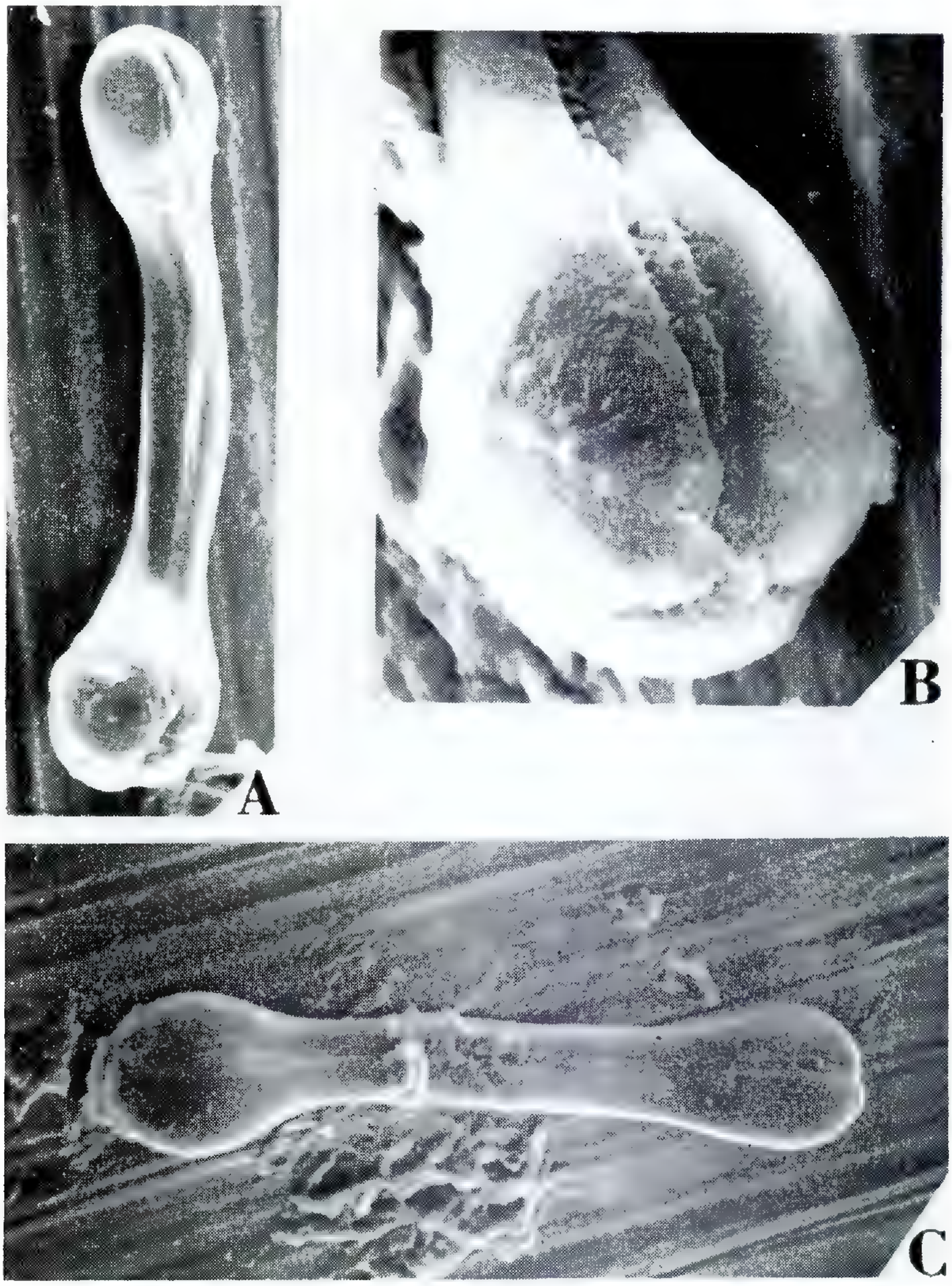

Figure 2. Pollen grains of *Dalea simulatrix*. A. 700X, note shape and furrow; B. 2000x, note tricolpate condition and smooth surface; C. 700X.

REFERENCES

ERDTMAN, G. 1960. The acetolysis method. A revised description. Svensk Bot. Tidskr. 54: 561-564.

MAHLER, WM. F. 1970. Pollen morphology of the *Dalea mollis-neomexicana* complex (Leguminosae) in the United States. Southw. Naturalist 15: 187-191.

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